DOCUMENT RESUME

ED 390 659 SE 057 099

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TITLE The Production and Utilization of Science and Engineering Doctorates in the United States.
INSTITUTION Stanford Univ., CA. Stanford Inst. for Higher Education Research.
SPONS AGENCY Alfred P. Sloan Foundation, New York, N.Y.; Office of Educational Research and Improvement (ED), Washington, DC.; Rand Corp., Santa Monica, CA. Inst. for Education and Training.
PUB DATE Aug 95
CONTRACT R117610039-91
NOTE 331p.
PUB TYPE Reports - Research/Technical (143) -- Statistical Data (110)

EDRS PRICE MF01 Plus Postage. PC Not Available from EDRS.
DESCRIPTORS *Doctoral Degrees; *Employment Potential; *Engineering; Graduate Students; Graduate Study; *Higher Education; Science Careers; *Sciences

ABSTRACT

This report describes a simulation of the supply and demand for science and engineering doctorates, time to complete the doctorate, departmental choice behavior, and related matters. An attempt was made to determine whether there is a credible case for long-term underemployment of people with doctoral degrees. It is concluded that about 22% of the new doctorates could fail to find suitable employment when the supply-demand system achieves steady state based on the conditions prevailing in the early 1990s. A new model for departmental behavior is also presented, in which departments choose faculty, doctoral students, and postdoctoral employment numbers to meet needs for teaching as determined by less-than-doctoral enrollments and needs for research as determined by sponsored project volume. Some findings of the study are summarized as follows: doctoral student numbers depend more on academic production needs than on the labor market; too many doctorates are being produced in engineering, math, and some sciences; increasing university sponsored research funding would worsen Ph.D. job prospects over the long run; Ph.D. attainment by students entering graduate study in science and engineering average 23% for U.S. students, 21% for foreign students, and 22% overall; median time to the Ph.D. degree is 5 years; attainment rates correlate positively with registered time-to-degree and with percent industrial employment; graduation rates tend to be lower in the high-status institutional seqments; and doctoral program size is more sensitive to overall undergraduate enrollments in fields with heavy general educational loads. (JRH)

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The Production and Utilization of Science and Engineering Doctorates in the United States

William F. Massy, Stanford University
Charles A. Goldman, RAND

July 1995

Stanford Institute for Higher Education Research

Discussion Paper

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The Production and Utilization of Science and Engineering Doctorates in the United States

William F. Massy, Stanford University
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July 1995

This research was supported by a grant from the Alfred P. Sloan Foundation, with partial support from the RAND Institute for Education and Training. The faculty interviews reported in Chapter 1 were funded in part by the U.S. Department of Education's Office of Education Research and Improvement (OERI) under contract R117610039-91. The authors are grateful to Beryle Hsiao, Marc Chun, and Joseph Castro for their expert research assistance, and to Janice Pang for editing the manuscript and producing the report. Copyright © 1995 by William F. Massy and Charles A. Goldman

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Stanford Institute for Higher Education Research

August 4, 1995

To: Recipients of "The Production and Utilization of Science and Engineering Doctorates in the United States"

From: William F. Massy and Charles Goldman

RE: New data and error correction

Data published in Table C-3A of the recent COSEPUP report (Committee on Science, Engineering, and Public Policy, "Reshaping the Graduate Education of Scientists and Engineers," Washington, D.C.: National Academy Press, 1995) reveal a significant anomaly in the government's 1991 estimate for doctorate employment in computer science. The report, which had not been published when we did our work, enabled us to approximate the correct figure (which is larger than the published one by a factor of four), fix the definitional problem we had noted earlier for bioscience, separate physics and chemistry, and add economics to our list of employment categories. We also corrected a logic error in Table 1.3 and in Table 1.7.

Corrected copies of Table 1.3, Table 1.7, and the "Executive Summary" are enclosed. Readers should note that the employment gap figure for computer science has dropped to 6.6 percent and that for bioscience has risen to 27.8 percent. The mean employment gap is now 22 percent, down slightly from the figure of 25 percent reported previously.

We are pleased to be able to refine our conclusions in light of the new data and apologize for any confusion.

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Table 1.3
Employment Gap
Physics plus Chemistry; Electrical Engineering

	Physics + Chemistry		Electrical Engineering	
Simulated data (base equilibrium)				
Retirements	559		165	
Total faculty	22,217		6,048	
Retirement rate	0.025		0.027	
Career length	39.7		36.7	
New doctoral degrees	2,870		1,288	
Percent degrees by U.S. citizens	55.8%		55.0%	
Simulated employment gap	2,311		1,123	
% of new degrees	80.5%		87.2%	
NSF doctorate employment data (1991)				
Doctorates employed in education	29,368		5,458	
Total employed doctorates	80,872		16,994	
Underemployment estimates				
Assumed retirement rate	0.025	0.030	0.025	0.030
Annual retirements	2,022	2,426	425	510
Gross employment gap				
Total new doctoral degrees	2,870	2,870	1,288	1,288
Estimated gross employment gap	848	444	863	778
% of new degrees	29.6%	15.5%	67.0%	60.4%
US-only employment gap				
Total US-citizen doctoral degrees	1,601	1,601	708	708
Estimated US employment gap	-420	-825	284	199
% of new degrees	-14.6%	-28.7%	22.0%	15.4%
Percent foreign degree recepients- to stay in U.S. for breakeven	33.1%	65.0%		
US-only employment gap assuming 20% of degrees are in other physical sciences				
Percent foreign degree recepients- to stay in U.S. for breakeven	1.4%	26.8%		

Table 1.7
Employment Gap
All Fields

	PHYS	CHEM	BIOS	GEOS	MATH	ECON	PSYC	CENG	CIVL	ELEC	MECH	CSCI
Simulated data (base equilibrium)												
Retirements	242	317	679	133	372	242	483	32	103	165	110	189
Total faculty	10,198	12,017	38,537	4,539	19,011	10,067	17,080	1,654	3,141	6,048	4,441	7,148
Retirement rate	0.024	0.026	0.018	0.029	0.020	0.024	0.028	0.019	0.033	0.027	0.025	0.026
Career length	42.1	37.9	56.7	34.2	51.2	41.6	35.4	51.7	30.5	36.7	40.3	37.9
New doctoral degrees	1,126	1,744	2,855	728	1,073	989	1,915	508	501	1,288	791	920
Percent degrees by U.S. citizens	73.4%	44.5%	82.9%	47.1%	65.6%	53.6%	96.7%	66.8%	47.4%	55.0%	49.1%	32.7%
Simulated employment gap	884	1,427	2,176	595	702	747	1,432	476	398	1,123	681	732
% of new degrees	78.5%	81.8%	76.2%	81.8%	65.4%	75.5%	74.8%	93.7%	79.5%	87.2%	86.1%	79.5%
NSF doctorate employment data												
Total employed doctorates	31,905	46,967	66,037	13,263	20,049	19,241	65,672	10,633	7,512	16,994	8,680	21,000
Employment gap estimates; assumed retirement rate = 0.0275												
Annual retirements	877	1,347	1,816	365	551	529	1,806	292	207	467	239	578
100% foreign retention												
New entrants to the labor market	1,126	1,744	2,855	728	1,073	989	1,915	508	501	1,288	791	920
Estimated gross employment gap	249	398	1,039	363	522	460	109	216	295	821	552	343
% of new degrees	22.1%	22.8%	36.4%	49.9%	48.6%	46.5%	5.7%	42.5%	58.8%	63.7%	69.8%	37.2%
50% foreign retention												
New entrants to the labor market	976	1,260	2,611	535	889	760	1,883	424	369	998	590	611
Estimated US employment gap	99	-87	795	170	338	230	77	132	163	531	351	33
% of new degrees	8.8%	-5.0%	27.8%	23.4%	31.5%	23.3%	4.0%	25.9%	32.5%	41.2%	44.4%	3.6%
0% foreign retention												
New entrants to the labor market	826	776	2,366	343	705	530	1,851	340	237	708	389	301
Estimated US employment gap	-51	-571	550	-22	153	1	45	47	31	241	150	-276
% of new degrees	-4.5%	-32.7%	19.3%	-3.0%	14.3%	0.1%	2.3%	9.3%	6.2%	18.7%	19.0%	-30.0%

The Production and Utilization of Science and Engineering Doctorates in the United States

William F. Massy, Stanford University
Charles A. Goldman, RAND

August 1995

Executive Summary

This report describes a simulation of the supply and demand for science and engineering doctorates, time to the doctorate, departmental choice behavior, and related matters. The modeling was motivated by a desire to determine whether there is a credible case for long-term structural underemployment of people with doctoral degrees (as well as by the need for basic research into the modeling of higher education). We conclude that there is indeed such a case. In fact, according to our results, about 22 percent of the new doctorates could fail to find suitable employment when the supply-demand system achieves steady state based on the conditions prevailing in the early 1990s.

The work breaks new ground from a methodological point of view. First we present a new model for departmental behavior. According to this model, departments choose faculty, doctoral student, and postdoctoral employment numbers to meet needs for teaching as determined by less-than-doctoral enrollments and needs for research as determined by sponsored project volume. A second model predicts doctoral graduation rates and the distribution of times to the degree. (Domestic and foreign students are treated separately.) A third model predicts faculty rank transitions and retirements. The three models come together to provide an overall simulation of the supply and the academic portion of demand for science and engineering doctorates.

Combining the models' output with data from the NSF's survey of doctoral employment produces estimates of the long-term supply-demand imbalance, and running the simulation with different exogenous drivers provides information on whether s current imbalance can be cured by adding sponsored research or expanding the system's teaching base. Parameter

estimation and simulation are based on data for some 210 research and doctoral-granting universities, separately analyzed for up to ten institutional segments per field, and an additional 1,000 non-doctoral granting institutions. Statistical tests and internal consistency of results provide technical support for the study findings.

The study findings are summarized below without the methodological context and caveats presented in the main report.

Doctorate Supply and Demand

1. Doctoral student numbers depend more on academic production needs—for example, service as research and teaching assistants—than on the labor market for persons holding the PhD. This view of departmental behavior, used in constructing and interpreting the model, is supported by faculty interviews conducted in conjunction with the project.

2. Too many doctorates are being produced in engineering, math, and some sciences. The long-term structural overproduction, estimated to average about 22%, contradicts dire predictions of long-term shortages. However, the statistics say nothing about short-term imbalances.

3. The following table presents estimated long-term overproduction as a percentage of the equilibrium number of PhDs produced annually. The figures are based on conditions extant in the early 1990s: they do not take account of any future employment increases.

Estimated Long-term Employment Gap

Field	% gap	Field	% gap
Mechanical Engineering	44	Geoscience	23
Electrical Engineering	41	Economics	23
Civil Engineering	33	Physics	9
Mathematics	32	Computer Science	4
Bioscience	28	Psychology	4
Chemical Engineering	26	Chemistry	(5)

Source: Table 1.7 in the Report

The gap is largest for mechanical and electrical engineering. Civil engineering, mathematics, biosciences, and chemical engineering also show gaps in excess of 25 percent. The gaps for computer science, psychology, and chemistry are essentially nil.

4. Increasing university sponsored research funding would worsen PhD job prospects over the long run. Immediate gains due to faculty expansion would give way to increased oversupply as expanded

doctoral programs begin to produce graduates. The same is true for increases in sub-doctoral enrollment.

5. The following tables present the sensitivity elasticities for sponsored research and sub-doctoral degree production (i.e., undergraduate general, undergraduate major, masters). Each elasticity represents the percentage change in the employment gap divided by an assumed percentage change in research or degree production.

Sponsored Research Sensitivities

Field	Elast.	Field	Elast
Chemistry	0.59	Mathematics	0.40
Electrical Engineering	0.58	Civil Engineering	0.32
Chemical Engineering	0.44	Economics	0.22
Bioscience	0.44	Psychology	0.20
Physics	0.42	Geoscience	0.11
Mechanical Engineering	0.40	Computer Science	–0.01

Source: Table 1.8 in the Report

Degree Production Sensitivities

Field	Elast.	Field	Elast
Bioscience	0.97	Chemistry	0.40
Computer Science	0.93	Electrical Engineering	0.39
Geoscience	0.63	Mechanical Engineering	0.31
Physics	0.50	Civil Engineering	0.16
Economics	0.47	Psychology	0.12
Mathematics	0.42	Chemical Engineering	0.11

Source: Table 1.9 in the Report

Research sensitivity is greatest for chemistry and electrical engineering, and smallest for geosciences and computer science. Degrees sensitivity is greatest for bioscience and computer science, and smallest for chemical engineering and psychology. There is essentially no correlation between the figures for research and degree sensitivity.

Doctoral Degree Production

6. PhD attainment by students entering graduate study in science and engineering average 23% for U.S. students, 21% for foreign students, and 22% overall. The following table gives the estimated long-term average doctoral attainment rates by field. (In reviewing the rates, note that the graduate matriculation statistics do not identify level of degree sought, and that not all students entering graduate study intend to seek the PhD.)

Estimated Long-Term Doctoral Attainment Rates by Field

Field	% grad	Field	% grad
Physics	44	Computer Science	18
Bioscience	36	Mathematics	17
Chemistry	36	Mechanical Engineering	16
Geoscience	26	Electrical Engineering	14
Chemical Engineering	21	Civil Engineering	8
Economics	21	Industrial Engineering	7
Psychology	18		

Source: Table 2.8 in the Report

7. Median time to the PhD degree (as a registered graduate student) is about 5 years for both U.S. and foreign students: this ranges from a high of almost $6\,^3/_4$ years for foreign students in industrial engineering to a low of $3\,^1/_3$ years for foreign students in math.

8. The fastest 10 percent of students graduate in about $3\,^1/_3$ years. The high is 4 years for U.S. citizens in computer science; low is $2\,^3/_4$ years for foreign students in math.

9. The slowest 10 percent of U.S. students take an average of $8\,^1/_3$ years; the slowest 10 percent of foreign students graduate much more quickly—in only about $6\,^1/_2$ years.

10. Attainment rates correlate positively with registered time-to-degree: it appears that the "naturals" graduate fairly quickly, with those remaining facing a struggle to attain the degree.

11. Attainment rates correlate positively with percent industrial employment, once type of field is taken into account. Holding industrial employment constant, graduation probability in science is greater than in engineering, a phenomenon we attribute to the greater opportunities for all-but-thesis professionals in engineering.

12. The following table shows estimated attainment rates by institutional segment and student origin:

Estimated Long-Term Attainment Rates by Segment

Institutional Segment	U.S.	Foreign	All
Private high-status	27%	15%	21%
Public high-status	28%	19%	23%
Private lower-status	33%	17%	25%
Public lower-status	28%	22%	25%
All segments	24%	22%	23%

Source: Table 2.11 in the Report

Graduation rates tend to be lower in the high-status institutional segments than in the lower-status segments. The effect of control on

graduation rates varies by citizenship category; no clear trend is apparent. When broken out by segment, graduation rates for U.S. citizens are substantially higher than those for visa-holders.

13. The "slow tail" of graduates tends to take longer to get the degree in the less elite institutional segments. The effect appears more pronounced in public than in private institutions. (There appears to be little difference among segments for the fast attainers.)

Departmental Behavior

14. Doctoral program size is more sensitive to overall undergraduate enrollments in fields with heavy general education loads (economics, mathematics, physics, chemistry, psychology, and biology) than in other fields.

15. Most institutions, when they have discretionary funds, intrinsically value doctoral students more strongly than faculty at the margin. We believe, however, that this is a short-run effect and that faculty may be valued more strongly given permanent income change.

16. Doctoral students and faculty appear to act as substitutes in production for the most elite segments—i.e., more doctoral students implies that fewer faculty will be required to meet degree-production and sponsored-research needs. In the least elite segments, however, additional doctoral students are associated with larger faculty numbers.

The core project was supported by the Alfred P. Sloan Foundation. The RAND Institute for Education and Training and the U.S. Department of Education's Office of Education Research and Improvement (OERI) provided additional partial support. However, responsibility for the conclusions, as well as any errors and omissions, rests with the authors. Copies of the report can be obtained at a cost of $20 to cover reproduction and mailing, by writing the first-named author at the Stanford Institute for Higher Education Research, Stanford University, Stanford, CA 94305 or by e-mailing the recipient's FAX number to hk.rac@forsythe.stanford.edu to receive a copy of the order form. Purchase orders and credit cards cannot be accepted. Free copies will be provided to government agencies and to others on an exception basis.

Revised August 3, 1995

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The work breaks new ground from a methodological point of view. First we present a new model for departmental behavior. According to this model, departments choose faculty, doctoral student, and postdoctoral employment numbers to meet needs for teaching as determined by less-than-doctoral enrollments and needs for research as determined by sponsored project volume. A second model improves prior predictions of doctoral graduation rates and the distribution of times to the degree for both domestic and foreign students. A third model predicts faculty rank transitions and retirements. The three models come together to provide an overall simulation of the supply and demand for science and engineering doctorates. Parameter estimation and simulation are based on data for some 210 research and doctoral-granting universities, separately analyzed for up to ten institutional segments per field, and an additional 1,000 non-doctoral granting institutions. Statistical tests and internal consistency of results provide technical support for the study findings.

The study findings are summarized below without the methodological context and caveats presented in the main body of the report.

Doctorate Supply and Demand

1. Doctoral student numbers depend more on academic production needs than on the labor market for persons holding the PhD. This view of departmental behavior, used in constructing and interpreting the models, is supported by faculty interviews conducted in conjunction with the project.

2. Too many doctorates are being produced in engineering, math, and some sciences. Overproduction, estimated to average at least 25%, contradicts predictions of long-term shortages given current demand.

3. The following table presents estimated overproduction as a percentage of the equilibrium number of PhDs produced annually based on conditions in the early 1990s.

Field	% gap	Field	% gap
Computer Science	50	Mathematics	32
Mechanical Engineering	44	Chemical Engineering	26
Electrical Engineering	41	Geoscience	23
Civil Engineering	33	Psychology	4
Physical science	32	Bioscience	<0

Source: Table 1.7 in the Report

The gap is largest for computer science, electrical engineering, and mechanical engineering. It appears smallest for Bioscience and Psychology, but this may be due to a confounding of clinical and scientific employment.

4. Increasing university sponsored research funding would worsen PhD job prospects in science and engineering over the long run. Immediate gains due to faculty expansion would give way to increased oversupply as expanded doctoral programs begin to produce graduates. The same is true for increases in sub-doctoral enrollment.

5. The following tables present the sensitivity elasticities for sponsored research and sub-doctoral degree production (i.e., undergraduate general, undergraduate major, masters). Each elasticity represents the percentage change in the employment gap divided by an assumed percentage change in research and degree production.

Sponsored Research Sensitivities

Field	Elast.	Field	Elast
Computer Science	–0.01	Mathematics	0.40
Mechanical Engineering	0.40	Chemical Engineering	0.44
Electrical Engineering	0.58	Geoscience	0.11
Civil Engineering	0.32	Psychology	0.20
Physics	0.42	Bioscience	0.44
Chemistry	0.59	Economics	0.22

Source: Table 1.8 in the Report

Degree Production Sensitivities

Field	Elast.	Field	Elast
Computer Science	0.93	Mathematics	0.42
Mechanical Engineering	0.31	Chemical Engineering	0.11
Electrical Engineering	0.39	Geoscience	0.63
Civil Engineering	0.16	Psychology	0.12
Physics	0.50	Bioscience	0.97
Chemistry	0.40	Economics	0.47

Source: Table 1.9 in the Report

Research sensitivity is greatest for chemistry and electrical engineering. Degrees sensitivity is greatest for bioscience and computer science, and smallest for chemical engineering and psychology.

Doctoral Degree Production

6. Doctoral graduation rates in science and engineering average less than 25%; average rates are about equal for US and foreign students. The following table gives the estimated long-term doctoral graduation rates, by field, averaged over both US and foreign students.

Field	% grad	Field	% grad
Physics	44	Computer Science	18
Bioscience	36	Mathematics	17
Chemistry	36	Mechanical Engineering	16
Geoscience	26	Electrical Engineering	14
Chemical Engineering	21	Civil Engineering	8
Psychology	18	Industrial Engineering	7

Source: Table 2.8 in the Report

The average estimated graduation rate was 23% for US students, 21% for foreign students, and 22% overall.

7. Median registered time to the PhD degree is about 5 years for both US and foreign students: this ranges from a high of almost $6\,^3/_4$ years for foreign students in industrial engineering to a low of $3\,^1/_3$ years for foreign students in math.

8. The fastest 10 percent of students graduate in about $3\,^1/_3$ years. The high is 4 years for US citizens in computer science; low is $2\,^3/_4$ years for foreign students in math.

9. The slowest 10 percent of US students take an average of $8\,^1/_3$ years; the slowest 10 percent of foreign students graduate much more quickly– in only about $6\,^1/_2$ years.

10. Graduation rates correlate positively with registered time-to-degree: it appears that the "naturals" get the degree fairly quickly and that

student groups differ mainly in terms of the staying power of those who must struggle for the degree.

11. Graduation rates correlate positively with percent industrial employment, once type of field is taken into account. Holding industrial employment constant, graduation probability in science is greater than in engineering, a phenomenon we attribute to the greater opportunities for all-but-thesis professionals in engineering.

12. The following table shows estimated graduation rates by institutional segment and student origin:

Estimated Long-Term Graduation Rates

Institutional Segment	US	Foreign	All
Private high-status	27%	15%	21%
Public high-status	28%	19%	23%
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Source: Table 2.11 in the Report

Graduation rates tend to be lower in the high-status institutional segments than in the lower status segments. The effect of type of control on graduate rates varies by citizenship category; no clear trend is apparent. When broken out by segment, graduation rates for US citizens are substantially higher than those for visa-holders.

13. The "slow tail" of graduates tends to take longer to get the degree in the less elite institutional segments. The effect appears more pronounced in public than in private institutions. (There appears to be little difference among segments for the fast attainers.)

Departmental Behavior

14. Doctoral program size is more sensitive to overall undergraduate enrollments in fields with heavy general education loads (economics, mathematics, physics, chemistry, psychology, and biology) than in other fields.

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The main project was supported by the Alfred P. Sloan Foundation. The RAND Institute for Education and Training and the U.S. Department of Education's Office of Education Research and Improvement (OERI) provided additional partial support. However, responsibility for the conclusions, as well as any errors and omissions, rests with the authors. Copies of the report can be obtained, at a cost of $20 each, by writing the first-named author at the Stanford Institute for Higher Education Research, Stanford University, Stanford, CA 94305 or by e-mailing the recipient's FAX number to hk.rac@forsythe.stanford.edu to receive a copy of the order form.

Chapter 1
Doctorate Supply and Demand

I. Introduction

A few years ago, one of us participated in an Office of Technology Assessment advisory panel whose charge was to assess the health of U.S. academic research. Not surprisingly, conversation at one of the meetings lamented the "underemployment" of young scientists and engineers—the difficulty of establishing oneself in a suitable post and developing an independent research career. A distinguished scientist in the panel suggested that Congress should appropriate sufficient additional research funds to provide America's doctorate-holders the chance to pursue effectively the careers for which they are trained. The argument was couched in terms of the national interest as well as on humanistic grounds, since, with underemployment, a portion of the investment in doctoral training is wasted.

That argument just didn't seem right. While expanding sponsored research budgets undoubtedly increases the demand for doctorates, one suspects there may be supply-side effects as well. Why should we believe that the demand effects outweigh the supply effects over then long run, after doctorate production has had a chance to adjust? Could it be that, while salutary at the beginning, increased research funding actually makes doctorate underemployment worse over the long run? And what about non-doctorate student enrollments? While increasing faculty places, they also may call forth new demand for doctoral students to help teach elementary courses—students who will, in due course, attain the PhD and enter the doctorate employment market.

Back-of-the-envelope calculations suggest that the idea of a structural supply-demand imbalance is not far-fetched. For example, if a moderately active doctorate-producing professor's career spans 40 years and he or she graduates one PhD every four years, the "reproduction rate" is ten to one. Suppose half the doctorates in the field are employed in academe, half the academic population works in research and doctorate-granting universities, and half of these are at least moderately active as defined above. This means that one-eighth of the doctorate population produce at least ten doctorates each, which implies an imbalance even before we take account of the occasional doctorate produced by less active faculty and the more active ones' greater productivity.

The doctorate-underemployment hypothesis ran counter to then-circulating reports about the impending shortage of doctorates to fill academic positions.[1]

While the two possibilities can be easily reconciled by invoking short-term labor-market transients, such as the bulge of retirements expected in the 1990s, differences in policy implications can be profound. If the long-term imbalance theory is correct, for example, calls for increased PhD production to alleviate an immediate shortage will increase underemployment in future decades—a classic "corn-hog cycle." Then too, there is the possibility that further study and new conditions will decrease the perceived, and the actual, likelihood of immediate shortages.

Data limitations make it hard to test the doctorate-underemployment hypothesis directly. The relevant unemployment statistics do not usually differentiate between employment in jobs requiring a doctorate and other kinds of professional and technical jobs—for example, jobs where a doctorate is helpful but not essential or where the doctorate-holder's innate ability and general technical knowledge provides an advantage not based on job-specific training. Hence the unemployment statistics may underestimate the actual degree of underemployment. Moreover, the supply-demand relations can change significantly from year to year, especially when one considers the data for particular fields. The so-called long-run equilibrium employment gap, which is rooted in structural rather than transitory relationships, is of greater interest.

How, then, can one study structural underemployment? Our approach has been to model the production of new doctorates and their uptake into traditional academic jobs, and then to interpret the resulting labor gaps using data on total U.S. doctorate employment. We developed highly detailed structural models for the academic sector—which represents virtually all of the supply of new doctorates but only a portion of the demand for their services. Not surprisingly, comparing one hundred percent of supply with a portion of demand produces a labor market gap. Hence the final step in our analysis was to ask whether the calculated gaps could likely be erased by employment in business, government, non-traditional employment in universities, and overseas. Our analysis shows that the answer to this question is "no"—that perhaps twenty-five percent of newly-minted doctorates end up underemployed.

The central hypothesis for the study can be summed up in two statements: the first static in character; and the second, dynamic. First:

> The "natural production rate" of doctorates exceeds the average steady-state uptake for new faculty and postdoctoral positions by U.S. institutions by more than the net demand from industry, government, and the rest of the world.

Moreover:

> Growth of the U.S. university system will absorb the excess doctorate supply during the expansionary period, but overproduction will reassert itself once the expansionary period has passed.

In other words, U.S. institutions tend to overproduce doctorates, and the overproduction cannot be cured by a one-time systems expansion. If the hypothesis is correct, universities must change their natural rate of PhD production: that is, the rate of dependency of PhD enrollment upon undergraduate and taught post-graduate enrollment, R&D funding, and other departmental costs and revenues.

Faculty interviews conducted prior to model construction suggest that: (i) the natural production rate of doctorates is driven by departmental needs for research and teaching assistants; and (ii) departmental doctoral-student intake is limited by financial constraints rather than output-market considerations. (The interview results are described in the next section.) Departments formulate their "requirements" for doctoral admits based on the faculty's perceived need for factors of academic production, not from assessments of the labor market for doctoral graduates. While science and engineering faculty do express concern about their graduates' employment prospects, these do not seem to dominate their decisions about doctoral-program size.

Doctoral applicant-pool quality and program intake also seem to be loosely coupled. The faculty we interviewed seemed sufficiently satisfied with applicant-pool numbers and quality to persist with their doctoral-enrollment plans. In short, the U.S. doctoral-production system appears to operate "open-loop," with quantities produced determined by suppliers according to their own agendas rather than as a function of output-market demand.

Our models quantify the aforementioned "natural production rate" for doctorates as a function of higher education undergraduate and taught post-graduate enrollments and R&D funding, and then explore the implications of the natural production rate for the doctorate supply-demand imbalance. The models consider both the static and dynamic imbalance hypotheses. However, our tests of the dynamic hypothesis are more precise because of the difficulty of assessing the demand from industry, government, and the rest of the world as needed for the static hypothesis. We concentrate mainly on the open-loop formulation, but we do test two models that incorporate negative feedback from the labor-market gap on the doctoral-student admissions rate.

The models do not represent a "forecasting study," since we have made no attempt to forecast the "drivers" of departmental decision-making: in our model,

total baccalaureate and in-major degrees, masters degrees, and sponsored research funding. The models track data on the drivers through the 1980s, so we are able to offer some insights about how recent enrollment and sponsored research trends have affected the doctorate labor gap. Mainly, though, we focus on whether the proposition of long-term supply-demand imbalance should be viewed as credible and relevant for policy.

II. Faculty Views About Doctoral Program Size

How departments determine the rate of intake for doctoral study emerged early as a key issue for model construction. There is no way to resolve this question using available secondary-source data, but departmental faculty certainly can provide the needed insights. We were fortunate that our modeling coincided with the beginning of field work on a separate, interview-based study of faculty roles and responsibilities.[2] Qualitative data produced by the interview study informed our model-building efforts, especially with regard to faculty choices about the natural production rate of doctorates and to whether doctoral production is "open loop" with respect to output labor gaps. This section describes the faculty view on these questions, as determined from our interviews.

We talked with 344 faculty at nineteen institutions, of which nine grant the doctorate. The interviews, which lasted about fifty minutes, covered a variety of subjects—including the production of doctorates. The interview protocol was designed to elicit conversations with faculty on their subjects of interest rather than to produce responses to a series of preset questions. The conversations were recorded and later transcribed into a database of "episodes," in which each episode describes the discourse on particular subject. The database contains some 5,000 episodes, of which 500 pertain to doctorate production. Departments in eight different subject areas (not all in science and engineering) are represented in the five hundred.

In general, the interview results confirmed that the natural production rate of doctorates is driven by departmental needs for research and teaching assistants, and that departmental doctoral-student intake is limited by financial constraints rather than output-market considerations. At the same time, there was much discussion regarding the difficulty that many graduates have in obtaining jobs. A sense of obligation by faculty to place graduates in good jobs was apparent, and department chairs and faculty appear to be concerned about this problem. However, they focus their energy and attention on the increased number of degrees awarded by lower-status institutions and the identification of new job

opportunities outside academia (or insistence that these do exist), rather than on a concerted effort to reduce enrollment in a significant way.

The following quotations from the database episodes illustrate the different ways departments approach the task of deciding how many students to admit:

> "I think the main ...criterion of how many people to admit is budgetary. It hasn't always been that way. The other factors used to be what is the size of the department, and would there be enough graduate students, number one, to man the elementary courses, number two to supply research, and those two things – and the number of applicants – decided how many to admit. But there has always been a budgetary component also..." (*Professor of Physics at RU*[3])

> "The factor that comes into the admission of graduate students is basically the number of faculty. We have 75 active graduate faculty. We asked, 'What is the reasonable number of graduate students a faculty member can handle?' We came up with the number 6. So 6 X 75 is 450." (*Professor of Computer Science at RU*)

> "It is always an uncomfortable mixture of quality and the number of TAs/RAs needed. It has to be. You can't admit more than you can identify funding for." (*Professor of Physics at RU*)

> "This is between me and the faculty member who is in charge of admissions. He says to me, 'How many do you want?'.. We both look at each other and say, 'I think we should go down a little bit.' I say, 'Fine.' And we go down a couple, 10% or so..." (*Professor of Physics at RU*)

The approaches are both formal and informal. They take into account (i) the number of faculty who can advise students; (ii) the number of teaching assistants needed for undergraduate courses (which is determined by number of undergraduate courses and students instructed and amount of TA funds); (iii) the amount of research money available to fund assistantships; and (iv) the character of the applicant pool. The labor market was not referenced as a formal criterion to determine the number of students to admit, but many faculty believe it influences the application pool and the types of jobs that graduates obtained. We will return to the applicant pool question at the end of this section, after elaborating on the importance of (ii) and (iii) and faculty views about the labor market for doctorate recipients.

There is a strong link between the number of teaching assistants needed by a department and the number of students admitted:

> "...how many teaching slots we have [is]...directly tied to how many students we can admit into our graduate program." (*Associate Professor of Chemistry at RU*)

"...it comes back to this TA problem. Some departments have these huge classes that need a lot of TAs in the first year, and so they accept a lot of people into the program so they can teach all these things and then weed people out after the first year, because then they'll get the next class in." (*Associate Professor of Chemistry at RU*)

A department's research needs also play a critical role in determining the number of students admitted:

"There's a real symbiosis here...We need our graduate students every bit as much as they need us because they do our research. It's their hands, and it's their minds...The students bring a freshness of approach, a lack of already-tattered thinking that's very valuable." (*Biochemistry Department Chair at RU*)

Many faculty members expressed concern about the labor market for their graduates:

"... I do worry really quite a bit about [doctoral] students – getting them all positions. It's a very tight job market, and there are very very few people who are getting positions. I know this feeling is definitely held by many many of my colleagues. They are certainly concerned about how well their graduate students will find jobs..." (*Assistant Professor of Physics at RU*)

"The squeeze is felt. It's being felt also because its hard for people who are getting their PhDs -- there aren't jobs. Some people are taking longer, and that's putting a squeeze on the number of new graduate students that we can admit..." (*Professor of Physics at RU*)

However, our respondents' concerns about job placement did not translate into substantive changes in admissions policy. In fact, faculty expressed strong resistance to decreasing enrollment at their own department, though some thought decreases could be made in other departments or at other institutions:

"There are some things that are true about how humanities departments are run that is deserving of some criticism, like over-production of PhDs in subjects that nobody is interested in but academics. Some may say that is also true of physics, so I have to be careful, even though I feel that physics research is more valuable." (*Professor of Physics at DG*)

"...[I] recently learned that the number of PhDs that we're producing per year in physics has risen from roughly 900 when I came to [university X] to something like 1400 now. That's absolutely crazy. I don't know of anyone at a major research university who is producing more PhDs than they were [then]. In fact, if anything, funding has gotten tighter and people have fewer students. The answer is in fact, these people are coming from places that used to not have graduate programs in physics at all. And

then these people are being dumped out on the pavement, so to speak." (*Professor of Physics at RU*)

Some faculty members acknowledged that a market exists for PhDs but claimed that they were already taking it into account or were identifying new opportunities in the market for their graduates:

> "I think in general there do seem to be mechanisms that affect PhD production that work regardless of whether the department makes it its priority. Graduate students tend to apply for things they believe their are jobs in and even if faculty may want more graduate students to continue their research programs, I think there's a general perception that if there are no jobs in that field, they are not going to get qualified applicants." (*Associate Professor of Psychology at RU*)

> "Now there is no central control on the number of PhDs. It's a market. But the real problem is manpower prediction is impossible, truly impossible...almost every manpower survey that has been done has been wrong. So I think until we get much more accurate predictive capability, more complex systems...I wouldn't want to make any kind of short term corrections." (*Professor of Physics at RU*)

> "We are over-producing if the only thing a PhD in physics can do is to go into academics. But that is not the only option...It is our responsibility to make sure that not only do we meet their expectations but that we shape their expectations in ways that are realistic and sensible. You take people and make clear to them what is realistic...You make clear where there are exciting problems outside of a university." (*Professor of Physics at RU*)

One faculty member sought to resist short-term market pressures:

> "The bottom line is, just ask yourself what common sense tells you about whether we need more technically trained people or fewer in the coming generations. And the answer is clearly we need more." (*Professor of Physics at RU*)

In short, faculty express concern about the labor market for PhDs and will do what they can to place their own students—but their concern does not lead to adjustments in doctoral student intakes. Faculty tend to believe that more scientifically-trained manpower is better than less and that job opportunities will materialize somehow. In any case, the department's short-run requirements for inexpensive research and teaching labor, and the desire of faculty to replicate their own skills are of stronger relevance to admissions decisions than the more abstract and distant concept of labor market balance.

But what about the doctoral applicant pool? Surely departments will cut back admissions if qualified applicants cannot be found. In other words, the doctoral

labor market might be regulated by prospective students even if faculty do not shoulder the responsibility for doing so.

We doubt that applicant-based regulation provides much of an equilibrating force. First, out interviews show that while precipitous quality declines may cause departments to limit admissions, slow declines tend to be taken in stride as long as minimum quality thresholds are maintained.[4] (Even the threshold norms may erode over time.) Respondents in many fields perceive the quality of U.S. applicants to be declining relative to their foreign counterparts, and many institutions are admitting more foreign students. The substitution can benefit the U.S. labor gap, but absent extensive language and cultural training, foreign TAs may undermine the quality of undergraduate education.

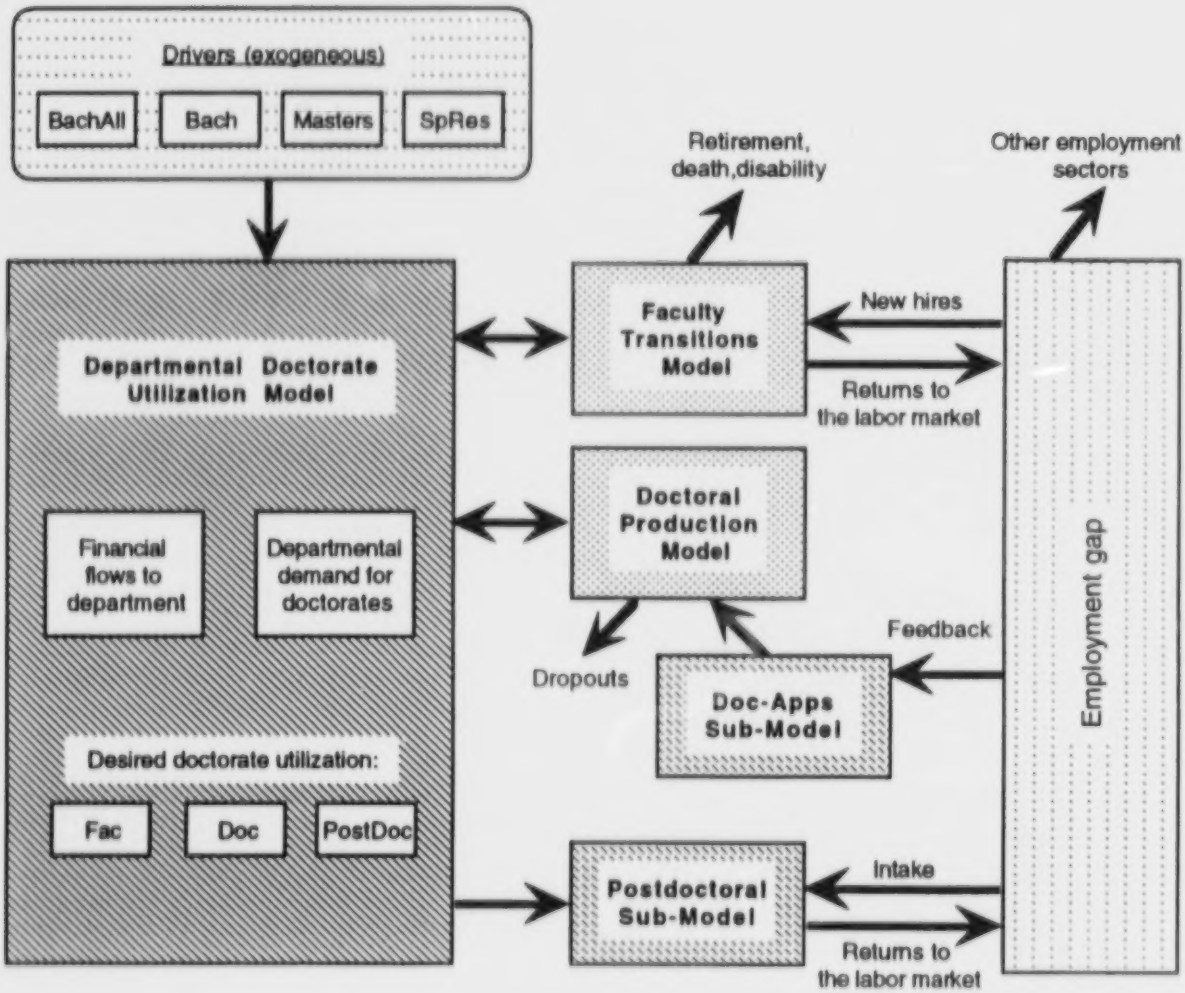
Substitution of foreign for domestic applicants aside, we believe that strong forces work against labor-gap regulation via application-based intake adjustments. First, strong departments tend to be insulated from precipitous quality declines simply because of their competitiveness. Moreover, they believe that intake reductions should take place in lesser-quality departments, not where doctoral training is at its best. Weak departments probably see bigger applicant-quality changes, but they are reluctant to reduce or eliminate doctoral programs because of the adverse effect on research. Faculty tend to equate academic productivity with research outcomes,[5] and having doctoral students is viewed as a necessary condition for research competitiveness.

In summary, strong research departments might be able to reduce the number of doctoral students in their production mix—in the process substituting higher-cost for lower-cost labor—without damaging their competitiveness. However, this is viewed as undesirable because it would lower the overall quality of doctoral education. Weaker departments and institutions find such a substitution difficult, because they enjoy less prestige and operate on smaller financial margins. Hence these departments and institutions try to maintain doctoral programs even when reduction or elimination makes sense from a system-wide perspective. The system is locked in a pattern of suboptimization. This inhibits adaptation to labor market imbalances, thus producing the "open-loop" situation hypothesized earlier in this chapter.

III. The Supply-Demand Simulation Model

Figure 1.1 presents a schematic diagram for our simulation of the supply and demand for doctorates in science and engineering. The model consists of three major components: the Departmental Doctorate Utilization Model; the Faculty Transitions Model; and the Doctoral Production Model. Two smaller models,

Figure 1.1
Simulation Model Schematic



labeled "submodels" in the figure, also enter the simulation. Starting with four "driver" or exogenous variables, the simulation computes a gross employment gap, which represents underemployment in the academic sector. Subtracting labor demand from other sectors produces the model's bottom line, the net "Employment gap" shown at the right of the diagram.

We analyzed the thirteen science and engineering fields shown in Table 1.1. The table also provides the abbreviations used in many of the tables and charts, and the numbers of private and public segments for each field as discussed below. To improve readability, we shall often refer to "Biological Sciences" as "Biology," to "Physics and Astronomy" as "Physics," and to "Mathematics and Statistics" as "Math." One field, Industrial Engineering, lacked data on faculty numbers by institution. Hence we omitted Industrial Engineering from the simulation and from the departmental utilization, faculty transition, and institutional segmentation models (Chapters 3 through 5). We had all the Industrial Engineering data needed for the doctorate production model (Chapter 2), so that model is applied to all thirteen fields.

Table 1.1
Fields, Field Symbols, and Numbers of Segments

Field name	Field symbol	Number of segments Private	Public	Total
Biological Sciences	biol	3	7	10
Chemical Engineering	ceng	2	4	6
Chemistry	chem	4	6	10
Civil Engineering	civl	2	4	6
Computer Science	csci	2	2	4
Economics	econ	4	6	10
Electrical Engineering	elec	4	6	10
Geological Sciences	geos	4	6	10
Industrial Engineering	indu	1	1	2
Mathematics and Statistics	math	4	6	10
Mechanical Engineering	mech	2	5	7
Physics and Astronomy	phys	4	6	10
Psychology	psyc	4	6	10

The study covers virtually all doctoral and four-year non-doctoral granting colleges and universities in the United States. The only institutions excluded were those which did not respond to the requisite government surveys and those where we encountered insurmountable missing-data problems in the course of analysis. Our final database included some 210 doctoral-granting and more than 1,000 non-doctoral granting institutions.

The data come mainly from the National Science Foundation, the National Research Council, and our own fieldwork. Most of the NSF data were extracted from the Foundation's CASPAR database. The NRC provided special tabulations on time-to-degree by institutional segment from its Survey of Earned Doctorates. Data on faculty transitions were extracted from various college catalogues obtained as a byproduct of interviews on faculty roles and responsibilities, including attitudes about doctoral production, that we conducted at nineteen institutions. We introduce further information about the data as we describe the models in which they are used.

Sponsored R&D dollars	Expenditure on research equipment
Full-time science & engineering personnel	Total graduate students in science & engrg.
Full-time science & engineering personnel	Part-time grad. students in science & engrg.
Science & engineering post-doctoral fellows	Masters degrees granted
Total doctoral degrees granted (survey I)	Total doctoral degrees granted (survey II)
Doctoral degrees granted to U. S. citizens	Bachelors degrees granted (whole institution)
Doctoral degrees granted to foreigners	Bachelors degrees granted (majors)

We decided early in our analysis that the standard institutional categories (e.g., the Carnegie classifications crossed with type of control) would be too coarse for modeling the doctoral-granting sector. Hence we devised a method for partitioning the public and private doctoral-granting institutions into relatively homogeneous groups ("segments"). The methodology, described in Chapter 5, begins with a factor analysis based on the ratios of certain departmental activity variables, shown below, to the number of faculty FTEs. A separate factor analysis was performed for the doctoral-granting institutions in each field. The factor scores were computed and rescaled to have mean zero and maximum value (for the highest-scoring institution) equal to one. The institutions were next separated by type of control, and each group was partitioned into an appropriate number of segments. Partitioning proceeded by working down the list of factor scores in such a way that the number of doctoral degrees is approximately equal across segments. For most fields this produced four private-sector segments and six public-sector ones; however, fields offered by smaller numbers of institutions ended up with fewer segments.

The doctoral-production model (Chapter 3) and the faculty-transitions model (Chapter 4) operate on individual segments or groups of segments. The departmental-utilization model (Chapter 3) and therefore the overall supply-demand simulation depend on the segment characteristics as well as the segment designations. Each segment can be characterized by two variables: whether it is

public or private (coded "0" and "1," respectively) and the average factor score for the institutions comprising the segment. Under this scheme, the "average doctoral-granting institution" in each field can be represented by setting the factor-score to zero and type-of-control to the proportion of private institutions in the sample. The "average-segment" designation is used in discussing the departmental-utilization results in Chapter 4, but it is not needed in the supply-demand simulation.

Driver Variables

We simulate the actions of academic departments and their students as they pertain to doctoral production and utilization. The simulation begins with the four exogenous ("driver") variables shown at the top of Figure 1.1.

BachAll: *the number of bachelors degrees awarded by the institution, a surrogate for total undergraduate enrollment and hence the department's general-education teaching load.*

Bach: *the number of bachelors degrees awarded by the department (i.e., in the department's discipline), a surrogate for the department's in-major teaching load.*

Masters: *the number of masters degrees awarded by the department, a surrogate for the department's taught-postgraduate teaching load.*

R&D: *the amount of sponsored research funding in the department's discipline, a surrogate for departmental research activity.*

The Departmental Choice Model

The exogenous variables drive the "departmental doctorate utilization model" or, more simply, the "departmental choice model," depicted in Figure 1.1. The choice model consists of three submodels. The first submodel estimates the department's budget constraint and the second estimates the department's "requirements" for faculty, doctoral students, and postdocs, based on the driver variables. The third submodel optimizes the numbers of faculty, doctoral students and postdocs by maximizing the department's "utility" subject to the budget constraint, the requirements constraints, and any limits on departmental flexibility—as might arise from a constricted doctoral applicant pool or a "tenured-in" faculty, for instance. The maximization proceeds by linear programming, using a piece-wise linear approximation of a quadratic utility function.

The coefficients for utility and the budget and requirements relations were obtained from cross-sectional data (for the field in question) using a multiple-

equation technique devised for the purpose. The estimation and maximization algorithms are fully described in Chapter 3, along with an analysis of the empirical results. As indicated above, the output of the departmental choice model consists of three variables: (i) the total number of departmental tenure-line faculty; (ii) the total number of doctoral students enrolled by the department; and (iii) the number of post-doctoral appointees in the department.

The Faculty Transitions Model

The "faculty transitions model" uses a Markov process to predict how the department's stock of faculty will change over time, given a particular set of signals from the departmental choice model. The data and the logit parameters estimator are described in Chapter 4. The model tracks faculty numbers by rank (assistant, associate, and full professor) and applies empirically-based transition probabilities for promotion, exit from the institution and return to the labor force, and exit due to retirement, disability, or death. New hires are assumed to be at the assistant professor level. Static faculty numbers elicit replacements, whereas expanding numbers always generate new hires. Departments are not allowed to reduce faculty numbers faster than the attrition predicted by the transition model, however. Hence the attrition figure enters the department choice model as a minimum-faculty-size constraint—as called out by the leftward-facing arrow connecting the two models in Figure 1.1.

The faculty transition analysis estimates entry to the faculty and exit from the faculty of a single department, but we still must account for the entries and exits from the labor market as a whole. The fraction of departures from individual departments that represent departures from the labor force is based on data from the 1988 National Survey of Postsecondary Faculty (NSOPF-88). Over a one-year period from 1986 to 1987, of all tenured faculty who left their departments, 2.7% retired, about 0.4% died or became disabled, and 1.2% sought a new job.[6] Thus, 28% of all tenured departures sought a new job and remained active in the labor force. Based on this parameter, the simulation counts 28% of the departures by full professors in the active labor force. All departures at the level of assistant or associate professor are counted in the active labor force.

While on the subject of employment transitions, we consider the simple system used to model postdoctoral appointments. We assume that each appointment lasts for exactly one year, after which the person returns to the labor pool. Adding postdocs to the model makes no difference to the supply-demand equilibrium but does affect the system's response to changes in the driver variables.

The Doctoral Production Model

Transition through the various stages of doctoral study proceeds much as described for the faculty; however, the underlying "doctoral production model" model is not a simple Markov process. The data on doctoral production are at once extensive and seriously incomplete, yet doctoral production (along with departmental choice) lies at the heart of our analysis. Therefore, as described in Chapter 2, we devoted significant resources to modeling the process in detail.

The doctoral production model assumes that each enrolled student can be characterized by a time-dependent "propensity to graduate" and "propensity to drop out." The graduation propensity rises with time-in-program, after a suitable gestation period, and then may decline as motivation deteriorates and other responsibilities intervene. The dropout propensity remains constant in this version of the model, since the lack of data on dropouts precludes a more refined structure. The peak graduation propensity and the dropout propensity vary over the matriculant population. An individual's propensities cannot be observed, but the population's profile (which is assumed to follow a gamma distribution) can be estimated. Additional parameters define the end of the gestation period (when the graduation propensity begins to rise), when the peak is reached, and the decline, if any, from the peak. The model also provides information on the time trend in matriculants (for which the data series is incomplete) and on the partitioning of matriculants between U.S. citizens and visa-holders. All parameters except the partitioning coefficient are estimated separately for citizens and visa-holders.

These assumptions allow us to construct an integrated stochastic model for predicting the doctoral transition probabilities needed for simulation, plus numerous other quantities of interest. Figure 1.2 shows the transitions scheme.

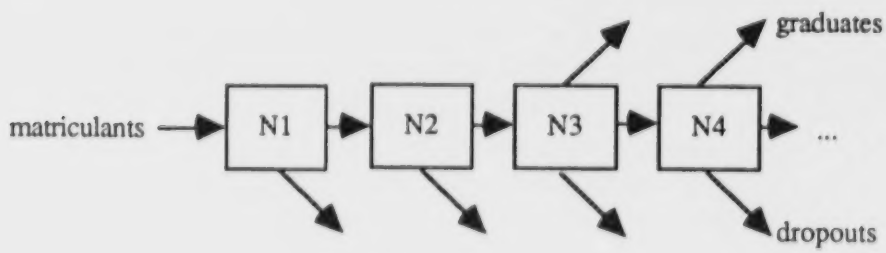


Figure 1.2
Doctoral Production Transitions

Matriculants enter the system as determined by the departmental choice model, possibly constrained by limits on the applicant pool. The students may drop out

after year one or move ahead to year two. Once the gestation limit has been reached (depicted here as year three), a student can graduate as well as drop out or continue. The stochastic model provides the transition probabilities, averaged over the propensity distributions, for each year. The model also provides the unconditional probabilities of graduation and dropout for each year, the asymptotic graduation probability, and the expected time-to-degree for various percentiles of the time-to-degree distribution.

Applicant-Pool Models

While most of our analysis uses an open-loop system, we did formulate and test two additional sub-models describing possible negative effects of supply-demand imbalance upon doctoral admissions. We describe the models as operating on the doctoral applicant pool, but one of them also could represent the impact of supply-demand imbalance upon departmental choice.

Theory suggests that potential students' willingness to pursue doctoral study depends in some way on the strength of the employment market for doctorate-holders. In terms of our simulation, the relevant assumption would be that application demand depends inversely on the employment gap—our measure of supply-demand imbalance. The larger the employment gap, the fewer the total number of doctoral applications, other things being equal. The linkage would gain strength if large employment gaps depress faculty salaries (and conversely), or if the employment gap is highly visible and the danger of under-employment highly salient to prospective candidates. We are not convinced that either condition represents reality, but that need not deter us from modeling "what if" questions about the sensitivity of applicant pools to the doctoral labor market.

The applicant-pool model consists of two elements: (i) a primary demand equation that links total doctoral applications to the employment gap; and (ii) a selective demand equation that allocates the primary demand among institutional segments.

Let A_t be total applicants (of acceptable quality) in year t, A_{kt} be the number of applicants available to segment k, and L_t be the employment gap in year t. Then the primary demand equation can be written:

$$A_t = q\,A_0\left(\frac{\text{expMA}[L_{t-1}]}{L_0}\right)^{-\alpha} \qquad (1.1)$$

where α is the demand elasticity parameter, t=0 represents the simulation's base year, and q represents the primary-demand selectivity factor in the base year. For example, q=1.1 indicates that ten percent more qualified applicants applied for

doctoral study than actually enrolled, and setting q large amounts to eliminating the employment gap's effect on applications from the model. The function "expMA[·]" represents an exponentially-weighted moving average as defined by the recursive relation:

$$\text{expMa}\left[L_{t-1}\right] = \lambda\,\text{expMa}\left[L_{t-2}\right] + (1-\lambda)L_{t-1}, \tag{1.2}$$

which smoothes the employment gap series.

Two types of allocative mechanisms suggest themselves: lexicographic allocation and proportional allocation. In lexicographic allocation, applicants are assigned in order of "segment status" as defined by the segment factor score. The lower-status segments are unable to fulfill their matriculation targets when primary demand is constrained, but demand surpluses have no effect. Lexicographic allocation implies that applicants agree on relative segment desirability, and that the lowest-quality applicants are discouraged first when employment gaps grow.

Proportional allocation assigns demand scarcity according to the segments' existing doctoral enrollment. (Once again, applicant surpluses have no effect.) This process is consistent with these two notions: (i) applicants of all quality levels are discouraged at the same rate; and (ii) higher-status institutions would rather forgo matriculants than accept those appropriate to a lower segment. The scheme also is consistent with the idea that departments decide to reduce doctoral enrollment, in response to underemployment, at similar rates.

Hybrid allocation rules also commend themselves. For example, one could use proportional allocation for a portion of the available applicant pool, and then assign the remaining applicants lexicographically to segments with open places. Such systems should produce results within the envelope of the two pure systems, however, so we did not pursue these ideas.

Each segment's applicant allocation enters the departmental choice model as a constraint on the maximum number of doctoral students that can appear in the linear-programming solution. Allocated matriculations not taken up by a given segment are passed along to the next lower segment in the lexicographic model, but they are lost to the system in the proportional model. Within each segment, the doctoral-support resources freed up by applications shortfalls are redeployed by the optimizer to faculty and/or postdoctoral appointments.

The Simulation System

The simulation system brings the various models together to project, for all U.S. four-year colleges and universities, the supply of new doctorates and returnees to the doctorate labor pool, and the demand for faculty and postdoctoral appointments. The system can be used to generate the long-term supply-demand equilibrium for a given driver configuration, or to compare the equilibria generated by different driver configurations.

The projections should be viewed in a comparative statics sense because the model was not designed to show the time path traversed in moving from one equilibrium to another. Such a path is of course generated in running the simulation, but the response to driver fluctuations is quicker than would be expected in practice. We could improve this aspect of the simulation by smoothing the departmental choice model so that, in a single year, departments move only part of the distance from their current status to the new optimum. Making the transition in a single step produces discontinuous rather than smooth-looking time series, but it also reduces simulation time and sharpens interpretations. It would be easy to introduce any desired degree of smoothing, however, if that turns out to be important.

Despite the simulation system's richness of detail, the basic model—the one without applicant pool limits—boils down to a large first-order Markov process. The state-space includes the numbers of U.S. and foreign doctoral students by program stage, faculty numbers by rank, and the number of postdoctoral appointments—all on a segment-by-segment basis. The model is Markovian because its behavior depends only on the current state variables, not on the path by which the current state was reached. Hence the model will evolve to a steady state where all the stocks and flows depicted in Figure 1.1 become time invariant. We refer to this steady state when describing "long-run equilibrium." We obtain the equilibrium figures by simply letting the model run until the requisite time-invariance is obtained.

Our results stem from three different equilibrium calculations, based on alternative driver specification. First we run the model to equilibrium with driver values for 1980, the first year of our data series ("Initial"). Next we calculate the time trend for each driver's evolution from 1980 to 1991 (1990 for R&D) and then let the model run to equilibrium with the drivers equal to their 1992 projected trend value ("Base-Period"). The base-period equilibrium invokes the initial equilibrium as its initial condition; then it tracks the actual driver values from 1980 to 1991 before settling down with constant drivers equal to the post-1991 projections. The third equilibrium calculation ("Projected") begins with the base-

period equilibrium and then tracks a set of assumed changes in the drivers: we used five years of two-percent annual increases in various driver combinations for most of the runs.[7]

The simulation's first-order Markov property is destroyed when we introduce the effect of past employment gaps on the doctoral applicant pool. The lag introduced in (1.1) produces a second-order difference equation that generates instability for some parameter values. There is no way to make the applicant-pool effect contemporaneous without iterating for each time period's solution, a process that would be prohibitively time-consuming. Hence we live with the instability, despite the interpretative complications it introduces.

IV. Results for Physics, Chemistry, and Electrical Engineering

This section presents detailed results for Physics, Chemistry, and Electrical Engineering. The results are interesting in their own right, and they also demonstrate the model's workings better than would be possible through further abstract discussion. We chose Physics as a demonstration field early in the project, because Physics appeared to have good data and be representative of the basic sciences. (As noted earlier, "Physics" as used in our models combines the fields of Physics and Astronomy as reported by the NSF.) Chemistry was added because the NSF data on doctorate employment aggregates the data for Physical Sciences. Electrical Engineering was included because we wanted one engineering discipline in our demonstration set, and because the results for this field illustrate some unusual behavior that we felt should be reported in better detail.

Initial and Base-Period Equilibria

Table 1.2 presents the initial (1980) and base (post-1990) equilibrium results for the three demonstration fields. The first line shows the employment gap: the difference between the annual production of new doctoral degrees and the net uptake for faculty and postdoctoral appointments. We see that the employment gap is positive and that it increases between the initial and base equilibria. The next group of lines presents data on total faculty, plus the number of faculty hires, exits, and retirements. Once again, all the figures increase over time. Note, too, the identities among faculty hires, exits, retirements, and the employment gap:

$$\text{hires} = \text{exits} + \text{retirements}$$
$$\text{employment gap} = \text{total degrees} - \text{retirements}$$

Exits represent movements out of present employment for reasons other than retirement, death, or disability ("retirement"); these people go back into the labor market and thus reduce the number of jobs available for new degree recipients.

Table 1.2
Initial and Base-Period Equilibrium Results
Physics, Chemistry, and Electrical Engineering

	Physics		Chemistry		Electrical Engrg.	
Drivers:	Initial	Base	Initial	Base	Initial	Base
Employment gap	736	884	1329	1427	623	1123
Faculty						
Total Fac	8427	10198	11079	12017	3565	6048
Hires	431	520	598	646	164	112
Exits	231	278	306	329	67	113
Retirements	200	242	293	317	98	165
Doctoral students						
Total Doc	9767	11706	13982	17266	16095	27125
Percent US	59%	67%	79%	36%	78%	61%
Total admits	2143	2568	4358	5427	5292	8787
Percent US	54%	62%	75%	34%	74%	62%
Total degrees	936	1126	1621	1744	721	1288
Percent US	66%	73%	87%	44%	79%	55%
Total dropouts	1207	1441	2735	3681	4569	7497
Percent US	45%	53%	74%	30%	79%	63%
PostDocs						
Total postdocs	1498	1987	2661	3606	119	156

The next block of figures shows the number of currently-registered doctoral students to have grown sharply between the two equilibria: around 20% for Physics and Chemistry and a whopping 68% for Electrical Engineering. The percentage of Chemistry students who are U.S. citizens declined from 79% to 36%, and the percentage in Electrical Engineering dropped by a lesser amount, whereas the U.S. percentage in Physics increased somewhat. Doctoral admissions, degrees, and dropouts all grew, by varying percentages depending on the shifting mix of U.S. and foreign students. Electrical Engineering degrees grew by more than 78%, for example, which reflects higher attainment rates for visa-holders as compared to U.S. citizens (see Chapter 2). The number of postdocs grows by about one-third in all three fields. The figures also highlight dramatic variations in postdocs per faculty member: 0.2 for Physics, 0.3 for Chemistry, and 0.03 for Electrical Engineering in the post-1990 period.

Driver Transition Effects

What accounts for the differences between the initial and base equilibria? Figures 1.3 through 1.5, which graph the driver variables, presents the main part of the answer. (The Figures are positioned at the end of the chapter.) R&D support for all three fields grew sharply between 1980 and 1991, for example, and the post-1990 projection remains at a high level. Overall undergraduate enrollments (*BachAll*) grew slowly over the period, with a spike at the end that was not fully captured by the time-trend calculation. (*BachAll* is of course the same for all fields.) Physics bachelors degrees grew during the early eighties and then flattened, Chemistry degrees declined significantly, and Electrical Engineering degrees grew dramatically until 1987 and then receded. Physics and Electrical Engineering masters degrees grew during the eighties, whereas Chemistry masters degrees remained essentially constant.

Figure 1.6, also positioned at the end of the chapter, shows the drivers' effects on employment. The graph's *y*-axis represents what we shall call the "employment deviation" or, more simply, "employment:" the change in employment gap from base period to the year in question, divided by the base-period faculty hiring level. (Footnote 6 illustrates the calculation.) The employment deviation seems more intuitively related to driver changes than the employment gap is, and normalization allows us to compare different fields regardless of faculty numbers.

The employment differentials are mostly positive during the 1980s, when the drivers were growing; then they drop sharply before rebounding somewhat to their base-equilibrium values. We would characterize the downward spikes as artifacts of the model's transitions to the post-1991 projected drivers, but the new, lower, long-run equilibrium values should be viewed as meaningful consequences of the expanded drivers.

To complete the graph set, Figures 1.7 through 1.9 trace out the simulation's main activity variables: faculty, faculty hires, doctoral students, admits and degrees, and postdocs. For Physics, faculty, doctoral student, and postdoctoral numbers rise steadily during the eighties and then flatten. Faculty hires fluctuate sharply with changes in the drivers. Recall that departmental decisions are not smoothed, whereas the total faculty numbers are smoothed through the transitions model. Doctoral admits fluctuate around a rising trend, which comes through in lagged and smoothed form in the series for new PhD-degrees granted. The Chemistry results are very similar to those for Physics. Electrical Engineering shows more fluctuation, but basically rising trends. The degrees-granted series shows the beginning of a damped oscillatory cycle caused by trend reversals for

bachelors degrees: doctoral admits were increased, decreased, and then increased again—with predictable consequences for the end of the pipeline.

Base Employment Gap

The employment gap presented in Table 1.2 and Figure 1.6 consists of net demand by employment sectors not included in the model ("excluded sectors"), plus any underemployment of persons holding doctorates. The excluded-sector figure consists of hires to doctorate-level positions minus returns to the labor pool for:

- non-faculty PhD-level positions in colleges and universities: e.g., research associates and temporary teaching staff;
- positions in other non-profit institutions, business, and government; and
- positions in foreign countries.

While data on the inflows and outflows by field do not exist, we do have information on total doctorate employment in both the domestic educational and domestic non-educational sectors. These data can be combined with information produced by the model to make rough approximations about underemployment.

The approximation methodology proceeds as follows:

1. Estimate the long-term equilibrium retirement rate for all employed doctorates, by applying an assumed career length to data obtained from NSF on 1991 employment.
2. Compare the simulated equilibrium PhD output with the estimated long-term equilibrium retirement numbers to obtain "gross underemployment"—that is, the excess of PhD production over retirement replacement demand, ignoring the return of foreign graduates to their home countries.
3. Calculate "net underemployment" by subtracting assumed numbers of foreign doctorate-attainers going to work abroad.

Notice that this procedure compares two long-run equilibria (for PhD production given today's drivers and retirement replacement based on today's employment levels) to produce a structural underemployment estimate. The procedure should generate valid estimates, within the limits of the data and parameter assumptions, providing today's employment levels reasonably approximate a steady state. If, on the other hand, current PhD employment is

below its equilibrium level—due to a constrained supply of PhDs, for instance—the procedure would overestimate long-term underemployment. We do not believe that current employment is so constrained: indeed, experience suggests that the PhD job market is soft. Hence this argument against our procedure need not be taken as disqualifying.

Table 1.3 pulls the data together and presents the calculations for Physics plus Chemistry, which comes as close to the NSF Physical Sciences aggregation as our data permit, and Electrical Engineering. We divided retirements by total faculty to obtain the retirement rate and its reciprocal, average career length. (The other

Table 1.3
Employment Gap
Physics plus Chemistry; Electrical Engineering

	Physics + Chemistry		Electrical Engineering	
Simulated data (base equilibrium)				
Retirements	559		165	
Total faculty	22,217		6,048	
Retirement rate	0.025		0.027	
Career length	39.7		36.7	
New doctoral degrees	2,870		1,288	
Percent degrees by U.S. citizens	55.8%		55.0%	
Simulated employment gap	2,311		1,123	
% of new degrees	80.5%		87.2%	
NSF doctorate employment data (1991)				
Doctorates employed in education	29,368		5,458	
Total employed doctorates	80,872		16,994	
Underemployment estimates				
Assumed retirement rate	0.025	0.030	0.025	0.030
Annual retirements	2,022	2,426	425	510
Gross employment gap				
Total new doctoral degrees	2,870	2,870	1,288	1,288
Estimated gross employment gap	848	444	863	778
% of new degrees	29.6%	15.5%	67.0%	60.4%
US-only employment gap				
Total US-citizen doctoral degrees	1,601	1,601	979	979
Estimated US employment gap	-420	-825	554	469
% of new degrees	-14.6%	-28.7%	43.0%	36.4%
Percent foreign degree recepients- to stay in U.S. for breakeven	33.1%	65.0%		
US-only employment gap assuming 20% of degrees are in other physical sciences				
Percent foreign degree recepients- to stay in U.S. for breakeven	1.4%	26.8%		

portions of the "Simulated data" section come directly from previous tables.) The next section shows the NSF data for doctorate-holders employed in education (all levels and kinds of posts) and total employment, as of 1991. Both academic and non-academic employment are presented for the sake of completeness, though only the total employment figure is used.

We must make an assumption about what retirement rate to apply to the pool of employed doctorates. We made two alternative assumptions: 0.025 and 0.030, which span results obtained from the simulation. Multiplying these rates by the total number of employed doctorates produces the annual retirements estimates shown in the second line of the underemployment section. These figures include faculty and non-faculty educational employment as well as non-educational domestic employment but not employment overseas. The next step computes gross underemployment (which does not take account of foreign net demand) by subtracting estimated retirements from the base-equilibrium number for new PhD. degrees. This calculation relies on the doctoral-supply element of the simulation to calculate long-term degree production based on post-1991 drivers but uses the NSF figures for the demand side.

The resulting gross underemployment estimates are substantial. They run from 15% of PhD production for the high-retirement physical sciences case to two-thirds of degree production for low-retirement Electrical Engineering.

Gross underemployment surely overstates the real employment imbalance because the figure includes all doctorate supply from U.S. institutions (both foreign and U.S. students) but only U.S. demand. The next set of figures, "U.S.-only underemployment," takes the other extreme position by excluding visa-holder degree production as well foreign demand. This produces a jobs shortage in physical sciences, whereas underemployment persists at high levels in Electrical Engineering.

The physical sciences result leads us to ask yet another question: "What portion of foreign new degree recipients would have to find work in the U.S. in order to balance the U.S. labor market?" The answer for physical sciences is between 33 percent and 65 percent, depending on the assumed retirement rate. This still doesn't tell the whole story, however: while the aforementioned calculations encompass all domestic physical sciences demand, the supply side covers only Physics (and Astronomy) and Chemistry. What about the other physical sciences fields? Lacking additional data, we simply assumed in the last line of Table 1.3 that our two fields comprise 80 percent of total physical sciences doctorates. For the low-retirement case, this approximately balances the labor market with no foreign degree recipients staying in the U.S., and about 27

percent of foreign recipients would have to remain to balance the high-retirement case.

On balance, we conclude that the simulated base employment gaps analyzed in Table 1.3 do indeed represent a material doctorate labor-market imbalance. The situation seems clear for Electrical Engineering, where 35 to 40 percent of U.S. degree recipients are predicted to be underemployed even if no foreign recipients remain in the United States. For physical sciences, the incidence of underemployment depends on how many foreign recipients remain. Atkinson reports that, for all science and engineering fields, about half of this group does in fact remain.[8] That appears more than sufficient to produce material physical sciences underemployment based on our figures.

Sensitivity to Driver Changes

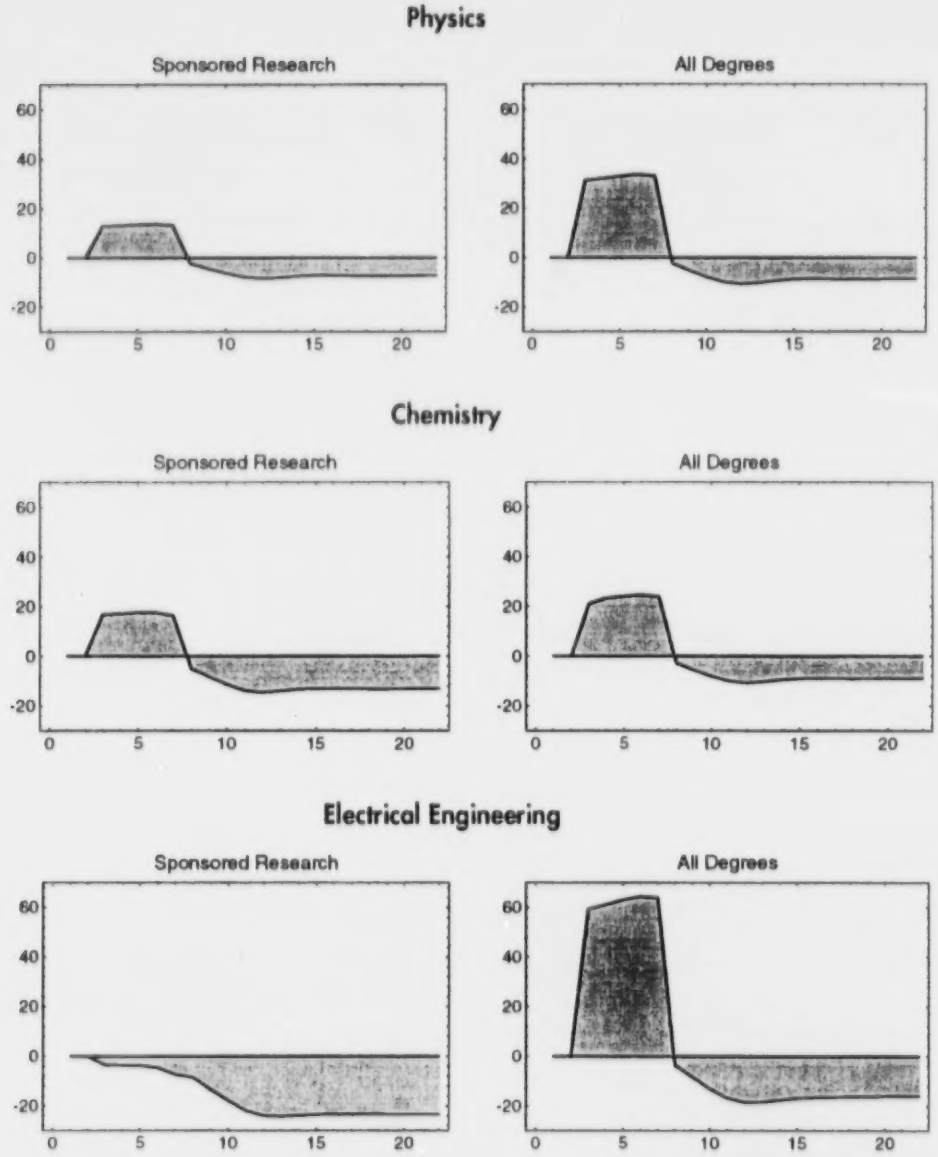
Dealing with non-faculty and foreign supply and demand becomes easier when we turn to the dynamic imbalance question. Looking at the simulation system's dynamic response eliminates what amounts to an integration constant—which, as we have just seen, is not easy to measure. The dynamic-response computational protocol is as follows:

1. start with the system in base equilibrium (that is, the equilibrium produced with the post-1990 projected drivers);
2. postulate certain changes in the driver variables and let the system run to a new equilibrium;
3. calculate the differences between the new equilibrium results and those for the base equilibrium.

As noted earlier, our basic assumption for driver change was a two percent annual increase for five years, for a total upward shift of ten percent.

Figure 1.10 graphs the response of employment to assumed exogenous increases in sponsored research (*R&D*) and degree production (*BachAll*, *Bach*, and *Mast*) for our three demonstration fields. The *y*-axes again represent the employment deviation divided by the number of faculty hires. Each simulation holds the drivers at their base values for two years to establish a zero point and then simulates the 5-year ramp of driver increases plus an additional 15 years to establish the new equilibrium. The general pattern is one of expanding employment during the time the drivers are rising, followed by a rebound to lower—and sometimes dramatically lower—employment levels.

Figure 1.10
Simulated Employment Sensitivity
To Increased Sponsored Research
(relative to the initial equilibrium)



The charts all have the same scale, so we can compare across driver selections and fields. Electrical Engineering produces the largest responses: in both directions in the all-degrees simulation and downward only for the sponsored research simulation. (We will return to the difference in Electrical Engineering's profiles shortly.) Chemistry produces the smallest responses for all degrees, whereas the Physics responses are smaller for sponsored research. Note, too, that the upward responses grow slight as the driver-expansion effects cumulate: in particular, a larger faculty generates more attrition which produces more employment even in the short run. The employment figures continue to fluctuate for a few years after the drivers stabilize, but the changes are small and equilibrium is clearly in hand by the end of the series.

Table 1.4 quantifies the employment profiles for the sponsored research case and adds further information about the simulations. The first line shows the results of departmental decision making for the base period ("before" the driver expansion), the fifth year of driver expansion ("during"), and at the new

Table 1.4
Sensitivity to Increased Sponsored Research:
Physics, Chemistry, and Electrical Engineering
(based on an annual two-percent increase for five years)

	Physics			Chemistry			Electrical Engineering		
	before	during	after	before	during	after	before	during	after
Departmental decisions									
Faculty hires	520	576	531	646	710	659	277	264	275
Doctoral admits	2568	2713	2665	5424	5804	5685	8787	9317	9243
Postdocs	1987	2127	2127	3605	3923	3923	156	163	164
Flow effects									
Faculty retirements	242	244	247	317	320	323	165	165	164
Doctoral degrees	1126	1131	1168	5424	1759	1834	1288	1291	1352
Employment gap	884	815	921	1427	1314	1511	1123	1144	1188
Total numbers									
Faculty	10198	10406	10406	12017	12266	12266	6048	6003	5988
Doctoral students	11706	12144	12144	17266	18144	18144	27125	28213	28516
Elasticities									
Faculty hires	na	1.08	0.20	na	0.99	0.20	na	-0.48	-0.10
Doctoral admits	na	0.56	0.38	na	0.70	0.48	na	0.60	0.52
Faculty	na	0.20	0.20	na	0.21	0.21	na	-0.08	-0.10
Doctoral students	na	0.37	0.37	na	0.51	0.51	na	0.40	0.51
Postdocs	na	0.70	0.70	na	0.88	0.88	na	0.40	0.51
Employment gap	na	-0.78	0.42	na	-0.79	0.59	na	0.18	0.58

equilibrium ("after" the driver expansion). Next we show the decisions' effects on the model's main flow variables: faculty retirements, doctorates granted, the raw employment gap,[9] and on the total numbers of faculty and registered doctoral students. The final section in the table converts these numbers into elasticities: the percent change from the base period divided by the 10 percent cumulative driver change.

Looking to the elasticities for faculty hires, we see that Physics shows the greatest sensitivity, Chemistry is not far behind, and—interestingly—that Electrical Engineering projects a decrease in faculty numbers as sponsored research increases. The explanation for this may lie in a substitution of doctoral students for faculty as sponsored research rises, or it may simply be an anomaly deriving from the fact that Electrical Engineering has many more doctoral students per faculty member than either Physics or Chemistry. At any rate, the long-run effect on faculty numbers is modest (though still negative) compared with the increase in doctoral admissions. All the variables rise in the case of Physics and Chemistry, and the number of doctoral students and postdocs, in particular, post relatively large elasticities. All the variables except Physics faculty hires have less than unit elasticity, however. Tables A-1 through A-3 at the end of the chapter extend the sponsored research sensitivity results to the segment level. They indicate that the effects of driver changes tend to be distributed across segments rather than being concentrated in a few places.

Table 1.5 presents the sensitivities to increased degree output. While we can vary degree output for total baccalaureates, in-major baccalaureates, and masters degrees separately, we made their growth rates equal for purposes of this presentation. Looking first at the table's bottom line, we see negative short-run elasticities that are considerably larger than the ones for sponsored research. The long-run sensitivities, however, are quite comparable. The simulated departments respond to enrollment growth by increasing faculty to a greater extent than the departments did for sponsored research. The new hiring produces immediate demand for faculty, but of course the hiring spurt subsides once the enrollment expansion ends. In the long run, the increases in doctoral enrollment drive up the employment gap, though the replacement demand associated with the larger faculty mitigates the effect somewhat.

Table 1.5
Sensitivity to Increased Degree Output: All Degrees
Physics, Chemistry, and Electrical Engineering
(based on an annual two-percent increase for five years)

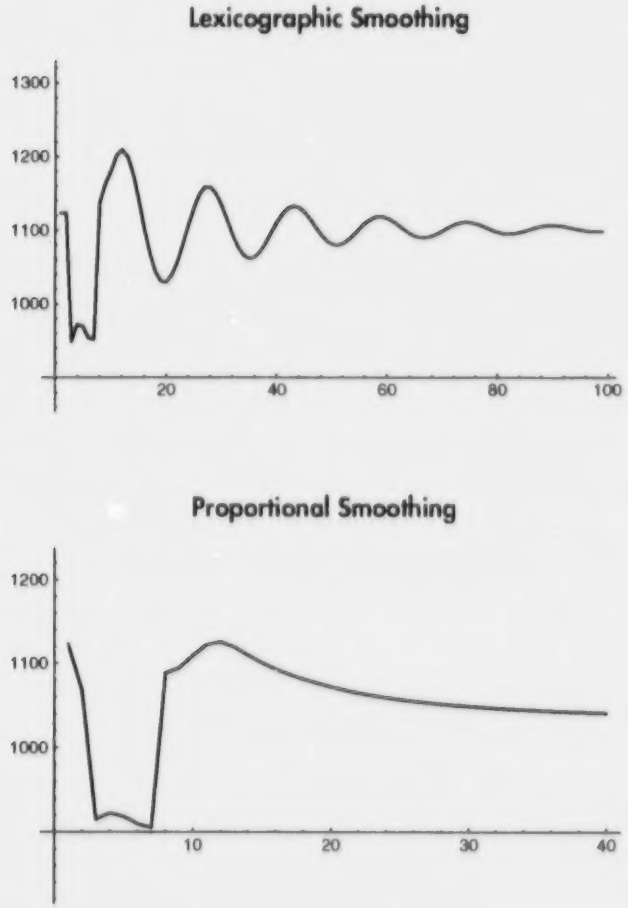
	Physics			Chemistry			Electrical Engineering		
	before	during	after	before	during	after	before	during	after
Departmental decisions									
Faculty hires	520	724	560	646	845	687	277	475	316
Doctoral admits	2568	2771	2707	5424	5744	5642	8787	9358	9195
Postdocs	1987	2053	2070	3605	3605	3605	156	156	156
Employment effects									
Faculty retirements	242	249	260	317	325	336	165	175	187
Doctoral degrees	1126	1134	1187	1744	1756	1819	8787	9358	9195
Employment gap	884	711	928	1427	1272	1484	1123	946	1167
Total numbers									
Faculty	10198	10802	10959	12017	12612	12771	6048	6726	6904
Doctoral students	11706	12224	12350	17266	17854	18008	27125	28149	28417
Elasticities									
Faculty hires	na	3.92	0.75	na	3.07	0.62	na	7.12	1.38
Doctoral admits	na	0.79	0.54	na	0.59	0.40	na	0.65	0.46
Faculty	na	0.59	0.75	na	0.49	0.63	na	1.12	1.41
Doctoral students	na	0.44	0.55	na	0.34	0.43	na	0.38	0.48
Postdocs	na	0.33	0.42	na	0.00	0.00	na	0.00	0.00
Employment gap	na	-1.95	0.50	na	-1.08	0.40	na	-1.58	0.39

The Feedback Model

Our next step was to introduce demand feedback. Figure 1.11 graphs the Electrical Engineering employment gap's response to an assumed five-year two percent annual increase in all three degree variables and in sponsored research. The upper panel depicts lexicographic smoothing, and the lower one depicts proportional smoothing. The demand elasticity (α) was set at one, the smoothing factor (λ) at 0.5, and the excess-demand factor (q) at 1.0.

Lexicographic feedback's oscillatory character is immediately apparent. The employment series fluctuates sinusoidally with a period of between 14 and 15 years and then damps slowly to a final value of 1099. Proportional smoothing, on the other hand, decays monotonically after the initial adjustment, to a final value of 1042. (Note the difference in time scales between the two graphs.) These final equilibrium values should be compared with the equilibrium with no demand feedback, where the employment gap was 1123.

Figure 1.11
Employment Gap With Demand Feedback



We tested several alternative parameter settings for the lexicographic case. Dropping all smoothing (λ=0) shortened the oscillation period to between 3 and 14 years but left the damping rate and ending value nearly the same. Cutting the elasticity to 0.5, again with zero smoothing, increased the damping to produce convergence in only two cycles while reducing the ending value to 1092. On the other hand, a run with the elasticity at 1.5 and zero smoothing produced undamped oscillations with a period of 13 to 14 years. We also tested Physics and Chemistry (and all the other fields), though not as extensively. The system appears to generate qualitatively similar results regardless of field, though the points of transition from monotonic to damped to undamped behavior vary, as do the periods of variation and the final equilibria. We did not observe oscillatory behavior in any of the proportional-allocation runs.

Table 1.6 provides some additional insight by disaggregating the lexicographic data. The table shows the number of doctoral applications and admissions for segments 4 and 10, the lowest segments in the private and public sectors, respectively, and for all segments. Notice that the demand constraint never quite binds on segment 4, though it comes within about 25% of admissions at the first peak. Segment 10 has a lower index-value than segment 4, and the applications constraint does constrain admissions. The segment-10 institutions substitute faculty for doctoral students (not shown in the table), which introduces a cyclical element into retirements at later dates. This cycle interacts with the doctoral-admissions cycle to produce the observed fluctuations—which, as we can see, are driven primarily by segment 10.

Proportional allocation spreads the effects across segments rather than concentrating them in the lowest segment or segments. The equilibrium

Table 1.6
Doctoral Applications and Admissions
With Demand Feedback: Electrical Engineering
(lexicographic allocation: elasticity=1.0, smoothing=0.5)

	Segment 4		Segment 10		All segments	
	Apps.	Adms.	Apps.	Adms.	Apps.	Adms.
Base period	3257	1938	1589	1589	8787	8787
Change year 1	3228	2039	1190	1190	8787	8787
Change year 5	4210	2176	2034	1845	10173	9984
First peak	2647	2107	541	541	8418	8418
First trough	3618	2105	1512	1512	9206	9206
Second peak	2974	2104	869	869	8742	8742
Second trough	3367	2105	1263	1263	9136	9136
Last value	3214	2105	1109	1109	8982	8982

employment gap is smaller than that for lexicographic allocation, other things being equal. We believe this derives from certain higher segments not using their doctoral applications "quota," which, by assumption, cannot be transferred to other segments.

While we do not yet fully understand the feedback model, we do feel comfortable with two conclusions. First, both lexicographic and proportional allocation stabilize the employment gap. Whereas open-loop doctoral demand increases the gap in response to driver growth, demand feedback brings the gap back to near its initial value or even decreases it somewhat. (This is not surprising, since the feedback model was designed to produce just such behavior.) Second, we believe that the gap reductions produced by the proportional model are somewhat artificial, since some demand clearly gets transferred across segments. The oscillations produced by the lexicographic model also are artificial and caused by rigidities which put the entire burden of response on the lowest segments. Introducing an element of proportionality, as discussed in Section II, probably would fix the problem, as would adding a degree of smoothing into departmental decision making or a stochastic forcing function almost anywhere in the system.

On balance, we did not find the feedback-based simulations particularly illuminating—though the experiments were well worth conducting. It now seems apparent that strong demand feedback keying off the employment gap will in fact adjust doctoral applications to bring the system to equilibrium at or near the "desired" gap. Since the target must be built into the model as a parameter, the long-term employment gap is preordained. The possibility of interesting dynamic behavior remains, but this should be embedded into a more refined analysis of the system's lag structure than we have been able to develop so far. In any case, we remain convinced that neither departments nor prospective doctoral students take close account of the doctorate employment gap.

V. Results for All Fields

Having concluded our tests for Physics, Chemistry, and Electrical Engineering, we proceeded to run the simulation on the nine remaining fields. The results are summarized in Tables 1.7 through 1.9. Table 1.7 describes the static employment gap, while Tables 1.8 and 1.9 describe the system's dynamic response to increases in sponsored research and degree output (all sub-doctoral degrees), respectively.

Table 1.7
Employment Gap
All Fields

	PHYS	CHEM	BIOS	GEOS	MATH	ECON	PSYC	CENG	CIVL	ELEC	MECH	CSCI
Simulated data (base equilibrium)												
Retirements	242	317	679	133	372	242	483	32	103	165	110	189
Total faculty	10,198	12,017	38,537	4,539	19,011	10,067	17,080	1,654	3,141	6,048	4,441	7,148
Retirement rate	0.024	0.026	0.018	0.029	0.020	0.024	0.028	0.019	0.033	0.027	0.025	0.026
Career length	42.1	37.9	56.7	34.2	51.2	41.6	35.4	51.7	30.5	36.7	40.3	37.9
New doctoral degrees	1,126	1,744	2,855	728	1,073	989	1,915	508	501	1,288	791	920
Percent degrees by U.S. citizens	73.4%	44.5%	82.9%	47.1%	65.6%	53.6%	96.7%	66.8%	47.4%	55.0%	49.1%	32.7%
Simulated employment gap	884	1,427	2,176	595	702	747	1,432	476	398	1,123	681	732
% of new degrees	78.5%	81.8%	76.2%	81.8%	65.4%	75.5%	74.8%	93.7%	79.5%	87.2%	86.1%	79.5%
NSF doctorate employment data												
Doctorates employed in education	29,368		62,767	5,508	14,280	na	24,850	2,369	3,068	5,458	2,931	2,494
Total employed doctorates	80,872		113,743	13,263	20,049	na	65,672	10,633	7,512	16,994	8,680	5,376
Employment gap estimates; assumed retirement rate = 0.0275												
Annual retirements	2,224		3,128	365	551	na	1,806	292	207	467	239	148
100% foreign retention												
Total new doctoral degrees	2,870		2 855	728	1,073	na	1,915	508	501	1,288	791	920
Estimated gross employment gap	646		-273	363	522	na	109	216	295	821	552	772
% of new degrees	22.5%		-9.5%	49.9%	48.6%	na	5.7%	42.5%	58.8%	63.7%	69.8%	83.9%
50% foreign retention												
Total US-citizen doctoral degrees	3,127		2,611	535	889	na	1,883	424	369	998	590	611
Estimated US employment gap	903		-517	170	338	na	77	132	163	531	351	463
% of new degrees	31.5%		-18.1%	23.4%	31.5%	na	4.0%	25.9%	32.5%	41.2%	44.4%	50.3%
0% foreign retention												
Total US-citizen doctoral degrees	1,602		2,366	343	705	na	1,851	340	237	708	389	301
Estimated US employment gap	-622		-762	-22	153	na	45	47	31	241	150	153
% of new degrees	-21.7%		-26.7%	-3.0%	14.3%	na	2.3%	9.3%	6.2%	18.7%	19.0%	16.7%

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Base Employment Gap

Table 1.7 shows substantial underemployment in engineering, with somewhat lower (but still substantial) figures for those science fields where the data appear to be good. For the five engineering fields, the employment runs between 25% and 50% of PhD production under the assumption that half of the visa-holding graduates remain in the United states. The figures for physical sciences (Physics and Chemistry), Bioscience, and Math run between 23% and 32%. The engineering and math employment gaps remain positive, between 5% and 20% of total degrees, even if we assume that none of the foreign graduates remain. However, thus assumption would wipe out the Physical Science and Geoscience gaps.

Data limitations make the situation much fuzzier for Bioscience and Psychology. We fear that the ambiguity of definition between Biology and the biomedical fields clouds the analysis in Bioscience. For example, our negative underemployment estimate could arise spuriously if the statistics for PhD production cover a broader scope than those for doctorate employment. A similar problem might arise in Psychology because of the juxtaposition of research and clinical employment, and of psychology and psychiatry. On the other hand, we cannot rule out the possibility that the calculated estimates for underemployment are real— that is, that Bioscience and Psychology do not exhibit employment gaps. As indicated in the table, we do not have any data for Economics.

The large employment gaps for Computer Science (50%) and Electrical and Mechanical Engineering (41-44%) are worthy of comment. We suspect these arise from the rapid expansion of these fields during the 1980s. Mushrooming research programs carried doctoral-student numbers to new highs, which lead our models to predict large numbers of doctoral degrees relative to the more slow-moving employment figures. If our models are correct, PhD graduates in these fields may expect an increasingly difficult job market unless employment expands dramatically.

We believe our assumptions to be relatively conservative, so we feel comfortable saying there is in a credible case for significant underemployment in engineering, physical science, Geoscience, and Math. If we had to characterize the gap for a lay audience, we would choose 25% of total degrees—the low end of the "50% foreign retention" range. For the five engineering fields, this would imply that about 200 new PhDs, on average per field, would fail to find suitable doctorate-level employment.

Sensitivity to Driver Changes

The sensitivities to sponsored research and degree growth, presented in Tables 1.8 and 1.9, depend only on the simulation and thus are easier to interpret. The tables begin with the base employment gap, in absolute terms and as a percent of doctoral degrees granted. Then we show the employment gap in the fifth year of the expansion period ("during expansion"), followed by elasticities for the simulation's key variables. This tableau is repeated at the bottom of the table for the long-run equilibrium results ("after expansion"). As in Section III, the drivers are assumed to grow at two percent per year for five years.

Looking to the sponsored research results in Table 1.8, we see that all the during-expansion employment-gap elasticities are negative except the one for Electrical Engineering we discussed earlier. The largest effect occurs in Bioscience, where the employment gap drops by 1.64 percent for every percentage-point addition to sponsored research. Computer Science presents the only exception, and here the elasticity is virtually zero. Faculty hires presents a similarly large elasticity, which explains why the effect on employment is so strong. Physics, Chemistry, and Math employment also shows considerable sensitivity to sponsored research. The same is true of doctoral admits and postdoctoral appointees, though these elasticities are almost always smaller than those for faculty hires. The effects for the other fields are smaller, but with the exception of Electrical Engineering, they show a consistent pattern.

The long-term effects also present a highly consistent pattern. The direction is to increase the employment gap, which is consistent with our hypothesis that increases in sponsored research cannot, by themselves, solve a doctorate supply-demand imbalance problem. Once again, Physics, Chemistry, Biosciences, and Math show fairly large elasticities, and this time they are joined by chemical , electrical, and mechanical engineering. The simulation tells us clearly that, without changes in academic production norms, increases in sponsored research tend to hurt long-term doctorate employment at rates that can easily exceed half the favorable short-term effect.

The short-term sensitivities to degree production all exceed one in absolute value, and most are larger than those for sponsored research. The long-term employment elasticities are lower than those for sponsored research in the four traditional engineering fields, however, with only computer science presenting a truly large effect. For science, degree production presents the larger long-term effect in five of the seven cases: Physics, Bioscience, Geoscience, Math and Economics. Such a result implies that sub-doctoral degree production calls forth more doctoral admits, on an equal-percentage basis, than sponsored research—

Table 1.8
Sensitivity to Increased Sponsored Research
All Fields

	PHYS	CHEM	BIOS	GEOS	MATH	ECON	PSYC	CENG	CIVL	ELEC	MECH	CSCI
Base employment gap	884	1427	2177	595	702	747	1432	476	398	1123	681	732
as percent of degrees	78%	82%	76%	82%	65%	76%	75%	94%	79%	87%	86%	80%
During expansion												
Employment gap	815	1314	1822	582	652	731	1400	468	386	1144	678	720
as percent of degrees	72%	75%	63%	80%	61%	74%	73%	91%	77%	89%	84%	78%
Elasticities												
Faculty hires	1.08	0.99	1.52	0.51	0.68	0.39	0.36	1.81	0.65	-0.48	0.80	0.36
Doctoral admits	0.56	0.70	0.79	0.18	0.45	0.26	0.24	0.56	0.48	0.60	0.49	0.00
Faculty	0.20	0.21	0.28	0.09	0.10	0.06	0.07	0.20	0.12	-0.08	0.12	0.06
Doctoral students	0.37	0.51	0.32	0.08	0.25	0.15	0.14	0.34	0.30	0.40	0.28	0.00
Postdocs	0.70	0.88	0.80	0.45	0.74	0.39	0.34	0.56	0.58	0.40	0.18	0.09
Employment gap	-0.78	-0.79	-1.63	-0.23	-0.70	-0.21	-0.22	-0.19	-0.30	0.18	-0.04	-0.16
Emp. gap/degrees	-0.82	-0.87	-1.69	-0.24	-0.74	-0.24	-0.24	-0.27	-0.33	0.16	-0.19	-0.17
After expansion												
Employment gap	921	1511	2272	601	730	763	1461	497	411	1188	708	731
as percent of degrees	79%	82%	76%	82%	66%	76%	75%	94%	80%	88%	86%	79%
Elasticities												
Faculty hires	0.20	0.20	0.34	0.11	0.13	0.08	0.08	0.25	0.15	-0.10	0.14	0.08
Doctoral admits	0.38	0.48	-0.15	0.12	0.33	0.18	0.18	0.41	0.38	0.52	0.34	0.00
Faculty	0.20	0.21	0.35	0.11	0.12	0.08	0.08	0.26	0.15	-0.10	0.15	0.08
Doctoral students	0.37	0.51	0.40	0.11	0.31	0.18	0.17	0.43	0.38	0.51	0.36	0.00
Postdocs	0.70	0.88	1.01	0.57	0.94	0.49	0.42	0.70	0.73	0.51	0.23	0.11
Employment gap	0.42	0.59	0.44	0.11	0.40	0.22	0.20	0.44	0.32	0.58	0.40	-0.01
Emp. gap/degrees	0.048	0.069	0.025	0.002	0.098	0.035	0.031	0.013	0.030	0.082	0.037	-0.017

Table 1.9
Sensitivity to Increased Degree Output: All Sub-Doctoral Degrees
All Fields

	PHYS	CHEM	BIOS	GEOS	MATH	ECON	PSYC	CENG	CIVL	ELEC	MECH	CSCI
Base employment gap	884	1427	2177	595	702	747	1432	476	398	1123	681	732
as percent of degrees	78%	82%	76%	82%	65%	76%	6%	94%	79%	87%	86%	80%
During expansion												
Employment gap	711	1272	1896	519	371	609	1096	426	331	946	572	610
as percent of degrees	63%	72%	65%	71%	34%	61%	4%	84%	66%	73%	71%	66%
Elasticities: "During"												
Faculty hires	3.92	3.07	2.76	3.96	4.66	3.37	3.96	10.39	4.33	7.48	6.76	3.67
Doctoral admits	0.79	0.59	1.72	0.99	0.69	0.73	0.39	0.24	0.48	0.65	0.64	1.32
Faculty	0.59	0.49	0.50	0.66	0.66	0.53	0.71	1.17	0.79	1.12	0.97	0.64
Doctoral students	0.44	0.34	0.69	0.54	0.42	0.41	0.23	0.15	0.32	6.44	0.35	0.70
Postdocs	0.33	0.00	0.00	0.00	0.00	0.00	0.35	0.00	0.00	0.00	0.00	0.36
Employment gap	-1.95	-1.09	-1.29	-1.28	-4.72	-1.85	-2.34	-1.06	-1.69	-1.58	-1.60	-1.67
Emp. gap/degrees	-2.00	-1.14	-1.42	-1.36	-4.76	-1.92	-2.51	-1.09	-1.72	-1.64	-1.70	-1.71
After expansion												
Employment gap	928	1484	2389	632	731	782	1449	482	405	1167	702	800
as percent of degrees	78%	82%	77%	81%	65%	75%	6%	93%	78%	86%	85%	80%
Elasticities												
Faculty hires	0.75	0.62	0.62	0.86	0.86	0.67	0.91	1.43	1.02	1.38	1.20	0.82
Doctoral admits	0.54	0.40	0.84	0.64	0.50	0.50	0.28	0.18	0.37	0.46	0.46	0.89
Faculty	0.75	0.63	0.63	0.84	0.83	0.67	0.90	1.48	0.99	1.41	1.23	0.81
Doctoral students	0.55	0.43	0.87	0.68	0.53	0.52	0.29	0.19	0.40	6.59	0.44	0.89
Postdocs	0.42	0.00	0.00	0.00	0.00	0.00	0.44	0.00	0.00	0.00	0.00	0.46
Employment gap	0.50	0.40	0.97	0.63	0.42	0.47	0.12	0.11	0.16	0.39	0.31	0.93
Emp. gap/degrees	-0.043	-0.033	0.082	-0.035	-0.108	-0.033	-0.163	-0.075	-0.168	-0.116	-0.111	0.033

which indeed is what happens in the simulation. Faculty size increases to a greater extent as well, though not enough for retirements to offset the extra degree production over the long run. Interestingly, the long-term employment gap per degree presents a mixed pattern of signs. In most fields, the employment gap does not grow proportionally to doctorate production as sub-doctoral degree output grows—another consequence of the faculty increases just mentioned.

VI. Conclusion

The results of our simulation have convinced us that both of the supply-demand imbalance hypotheses described in Section I are credible. While we cannot prove that such imbalances exist, our painstaking efforts to model PhD production and faculty demand have projected base imbalances in every case for which we could obtain the requisite data, and for long-term dynamic imbalances in 23 of the 24 cases reported. The results for different fields rest on entirely separate datasets, so they can be regarded as largely independent replications. We did not expect such consistency, and we are pleased with the model's performance. Mostly, though, we are pleased to be able to offer policy advice from a solid empirical base.

The implications of this study for policy seem clear. U.S. institutions appear to be producing more doctorates than the market will accept, but the solution does not lie in funding expansion—though more money for academic science and engineering maybe desirable on other grounds. Unless one is prepared to increase real funding in perpetuity, which hardly seems likely, other mitigations for doctorate underemployment must be sought.

We can only speculate on the kinds of mitigations. One approach is to improve the development and dissemination of labor-market data, so that prospective students and departmental faculty will be more cognizant of imbalances. Better information would probably help, but one can question whether it would be sufficient to counter the intra-departmental supply-side forces favoring doctorate production.

It seems to us that the ultimate answer must lie in academic restructuring, in a change in the mix of doctoral-student utilization in academic production generally. Hence the problem of doctorate supply-demand imbalance joins with those of the academic ratchet,[10] the shift of faculty time from teaching toward research, and the alleged over-use of doctoral students in undergraduate instruction as spurs to academic restructuring. We shall be writing on this subject in the months ahead.

Figure 1.3
Driver Values: 1980-1994
Physics

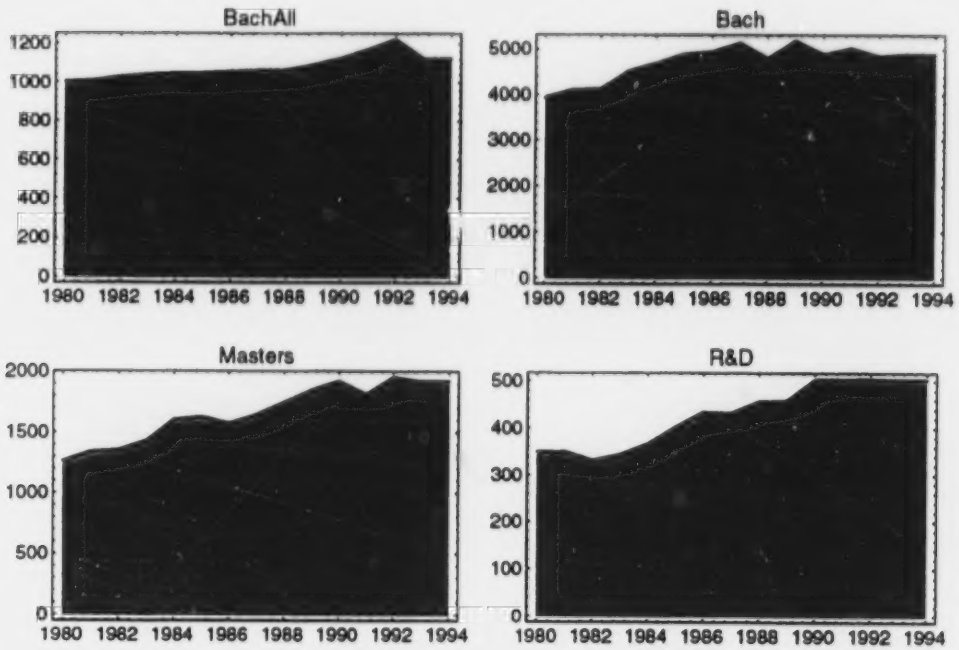


Figure 1.4
Driver Values: 1980-1994
Chemistry

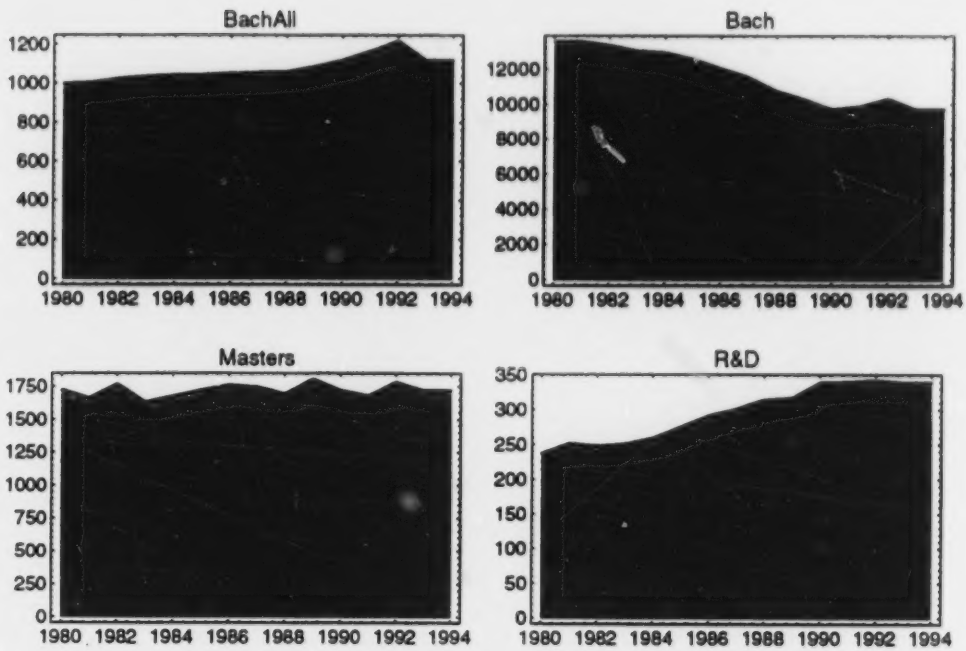


Figure 1.5
Driver Values: 1980-1994
Electrical Engineering

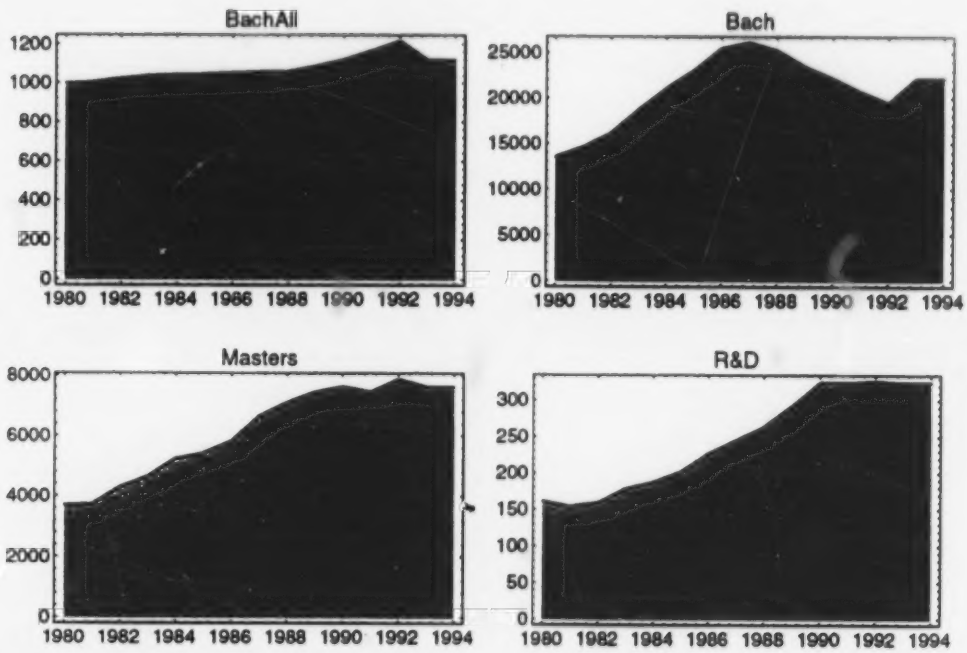
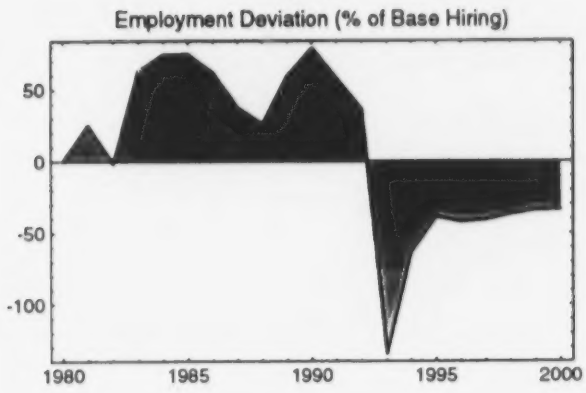
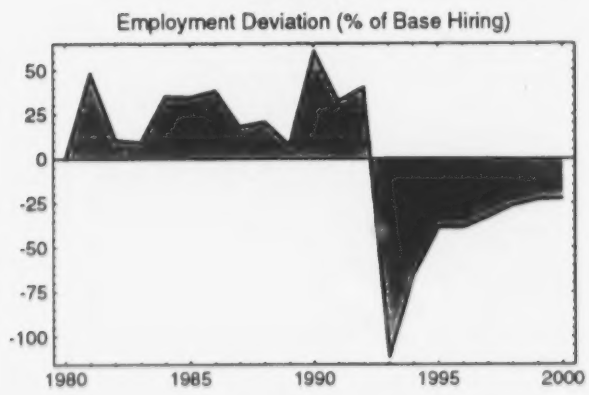


Figure 1.6
Simulated Employment: 1980-2000
(relative to the initial equilibrium)

Physics



Chemistry



Electrical Engineering

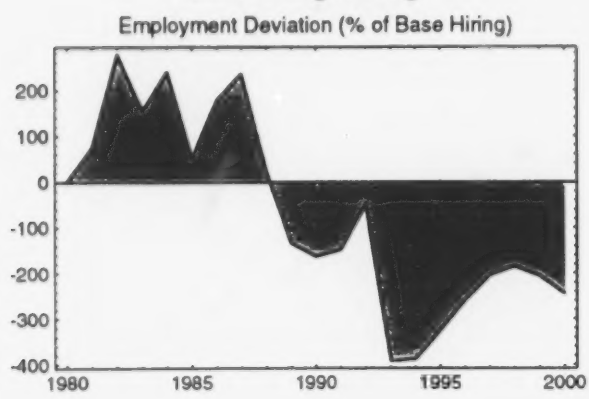


Figure 1.7
Simulation Output Detail: 1980-2000
Physics

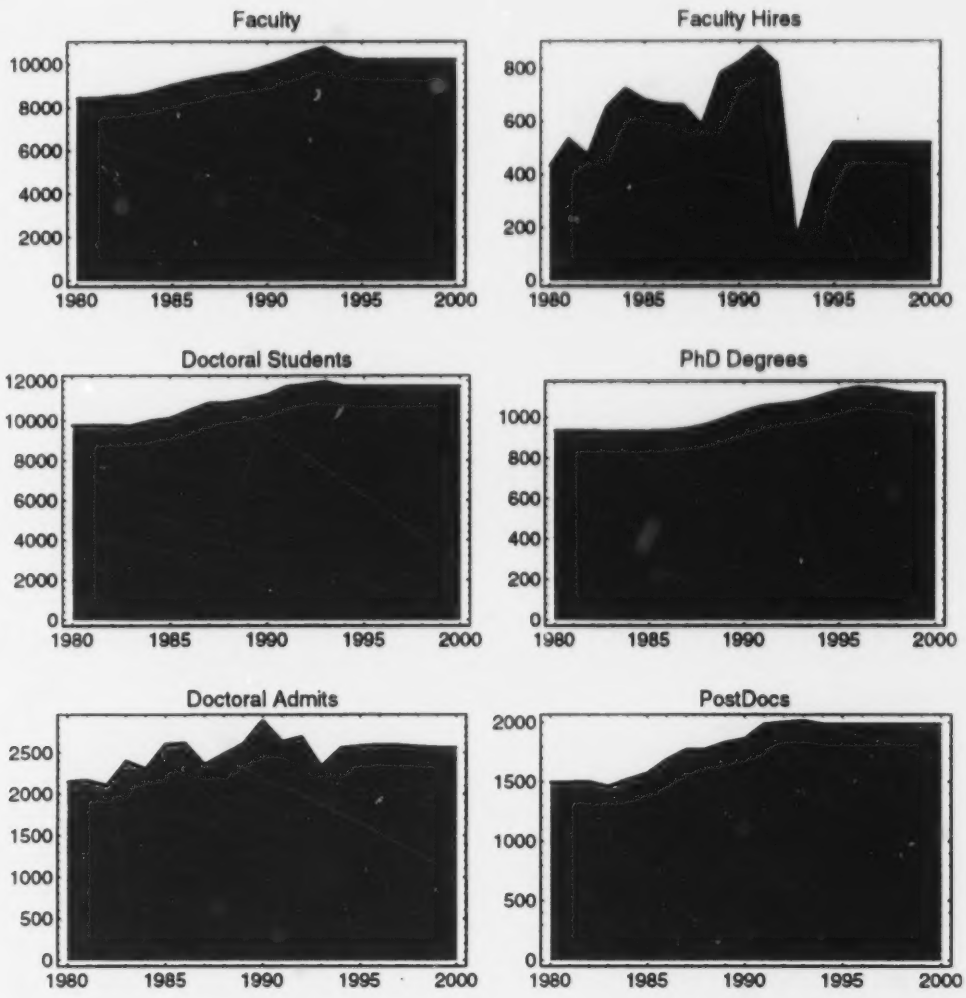


Figure 1.8
Simulation Output Detail: 1980-2000
Chemistry

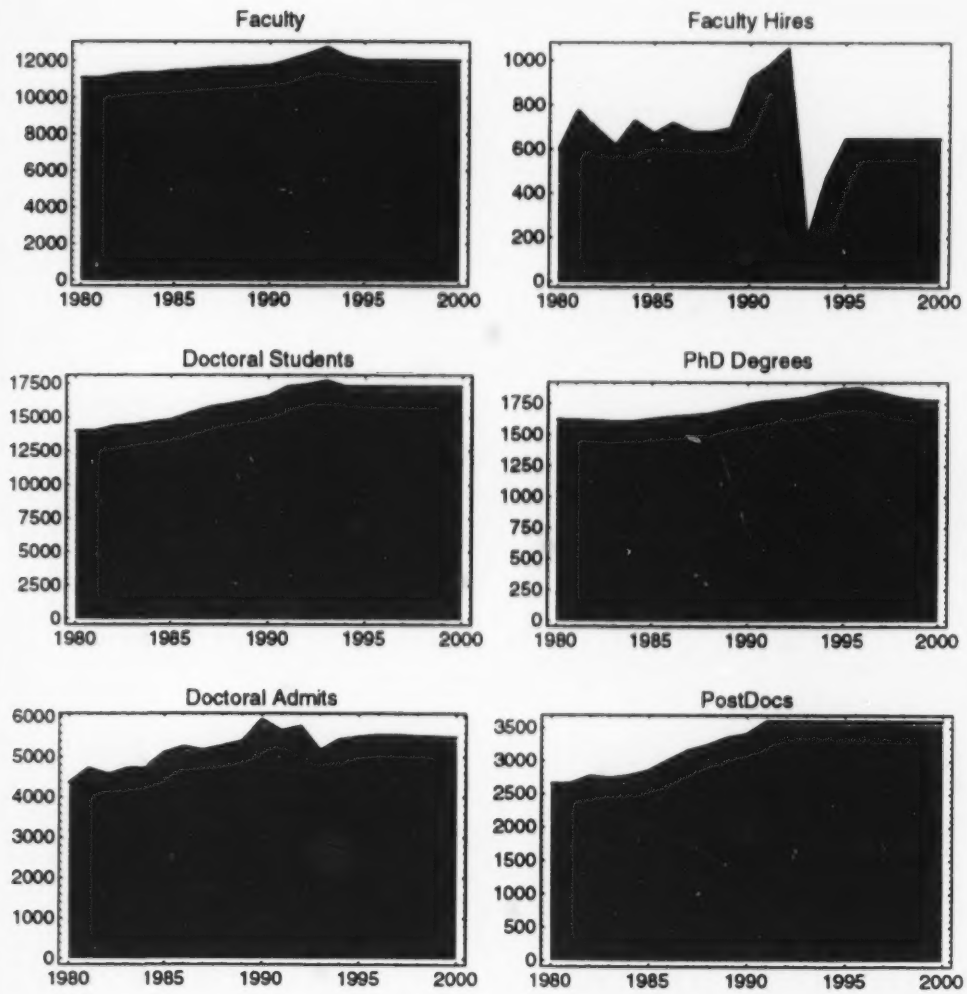


Figure 1.9
Simulation Output Detail: 1980-2000
Electrical Engineering

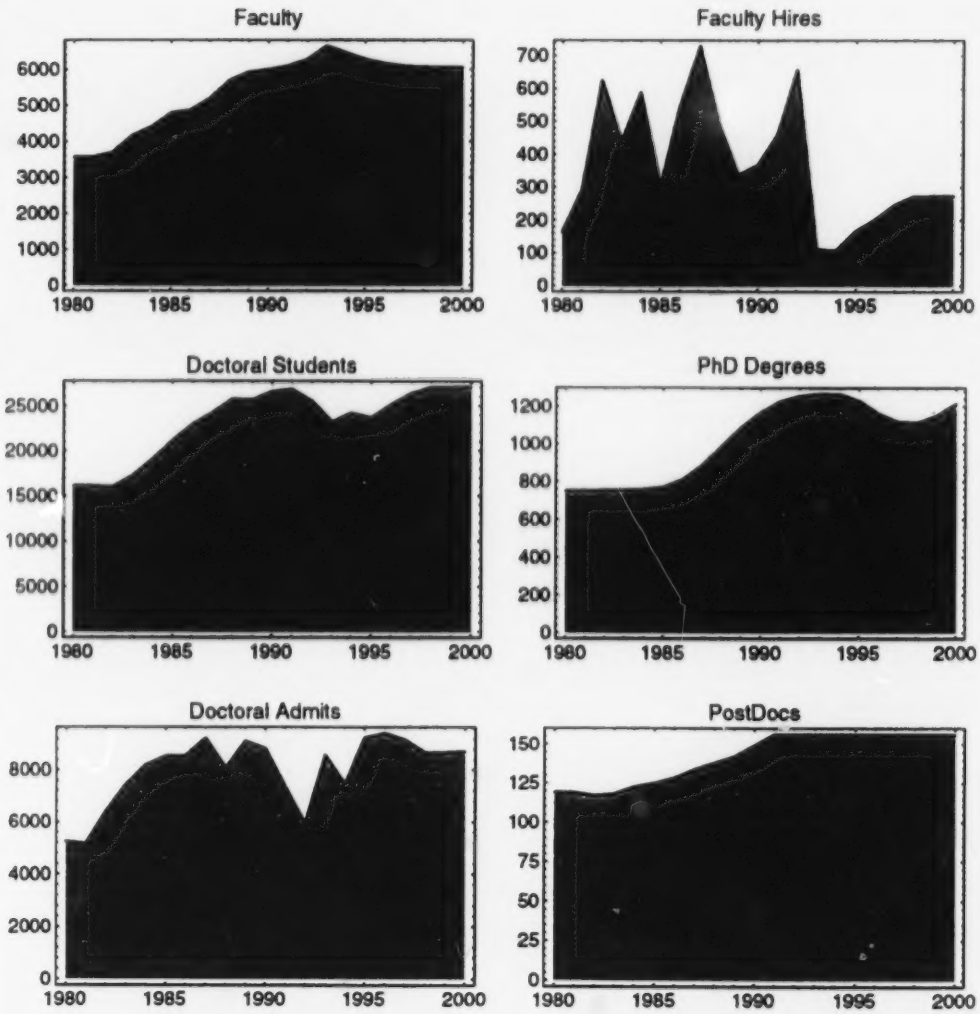


Table A-1.1
Sensitivity to Increased Sponsored Research:
Physics, by Segment
(based on an annual two-percent increase for five years)

	Doc admits			Faculty hires			Postdocs		
Seg.	before	during	after	before	during	after	before	during	after
Private doctoral									
1	184	197	193	7	10	8	215	230	230
2	255	273	267	12	15	12	232	248	248
3	162	171	168	12	14	12	115	124	124
4	306	322	317	41	46	42	203	218	218
Public doctoral									
5	195	203	200	9	11	10	125	133	133
6	205	214	211	16	18	16	123	131	131
7	265	288	280	21	26	22	282	304	304
8	272	287	282	24	28	25	208	223	223
9	243	257	254	28	32	28	184	198	198
10	481	501	494	65	71	66	300	319	319
Non-doctoral									
11	-	-	-	75	75	75	-	-	-
12	-	-	-	85	86	85	-	-	-
13	-	-	-	127	145	130	-	-	-
Total	2568	2713	2665	520	576	531	1987	2127	2127

Table A-1.2
Sensitivity to Increased Sponsored Research:
Chemistry by Segment
(based on an annual two-percent increase for five years)

	Doc admits			Faculty hires			Postdocs		
Seg.	before	during	after	before	during	after	before	during	after
Private doctoral									
1	425	468	457	12	17	13	553	601	601
2	460	507	495	16	22	17	396	436	436
3	691	741	726	42	49	43	381	415	415
4	463	487	477	11	15	12	262	289	289
Public doctoral									
5	465	488	478	14	17	14	354	377	377
6	506	543	528	18	23	19	375	407	407
7	489	524	514	22	28	24	320	349	349
8	502	538	527	26	31	27	375	403	403
9	501	536	526	26	32	27	254	280	280
10	923	971	957	52	60	53	334	366	366
Non-doctoral									
11	-	-	-	119	120	119	-	-	-
12	-	-	-	134	137	135	-	-	-
13	-	-	-	154	160	155	-	-	-
Total	5424	5803	5685	646	710	659	3605	3923	3923

Table A-1.3
Sensitivity to Increased Sponsored Research:
Electrical Engineering, by Segment
(based on an annual two-percent increase for five years)

	Doc admits			Faculty hires			Postdocs		
Seg.	before	during	after	before	during	after	before	during	after
Private doctoral									
1	711	746	746	2	0	1	15	16	16
2	777	853	835	7	3	6	19	20	20
3	683	772	746	14	10	13	31	31	31
4	1938	2084	2040	38	34	37	22	23	23
Public doctoral									
5	451	460	457	11	11	11	15	16	16
6	390	404	400	11	10	11	9	9	9
7	368	385	381	11	10	11	6	7	7
8	839	893	878	20	18	19	6	6	6
9	1040	1128	1103	29	27	28	21	22	22
10	1589	1684	1657	45	43	43	15	16	16
Non-doctoral									
11	-	-	-	5	5	5	-	-	-
12	-	-	-	37	43	38	-	-	-
13	-	-	-	50	50	50	-	-	-
Total	8787	9409	9243	277	264	275	164	165	165

References

Atkinson, Richard C. [1990]. "Supply and Demand for Scientists and Engineers: A National Crisis in the Making," *Science* 248 (April 27), pp. 425-432.

Massy, William F. and Andrea K. Wilger [1992]. "Productivity in Higher Education: A New Approach," *Educational Evaluation and Policy Analysis* 14, no. 4, pp. 361-376.

Massy, William F. and Andrea K. Wilger [1995]. "Faculty Productivity," *Change*, forthcoming July/August 1995 issue.

Massy, William F., Andrea K. Wilger, and Carol Colbeck [1994]. "Overcoming 'Hollowed' Collegiality," *Change* 26, no. 4, pp. 10-20.

McGuire, Michael, D. and Janet A. Price [1989]. "Faculty Replacement Needs for the Next 15 Years: A Simulated Attrition Model," paper presented at the Annual Forum of the Association for Institutional Research (Baltimore, MD: May 29, 1989).

National Center for Education Statistics [1991]. *Profiles of Faculty in Higher Education Institutions, 1988*. NCES 91-389.

Western Interstate Commission for Higher Education (WICHE) [1992]. *Bringing into Focus the Factors Affecting Faculty Supply and Demand: A Primer for Higher Education and State Policymakers*, Boulder, CO: March 1992.

Notes

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[1]C.f. Atkinson[1990].

[2]The Faculty Roles and Responsibilities project was funded by the Consortium for Policy Research in Education (CPRE) under a grant from the U. S. Department of Education's Office of Education Research and Improvement (OERI), with Massy as principal investigator. A portion of the fieldwork also was supported by the Alfred P. Sloan Foundation in connection with the project reported here. The project has produced two publications so far: Massy, Wilger, and Colbeck [1994], and Massy and Wilger [1995]. A book is in preparation.

[3]"RU" refers to "Research University" as used in the Carnegie Classification; "DG" refers to "Doctorate-Granting University."

[4]Supporting quotations will be added in the next release.

[5]Massy and Wilger [1995].

[6]National Center for Education Statistics, *Profiles of Faculty in Higher Education Institutions, 1988*, NCES 91-389 (August, 1991), p. 20 (retirements) and p. 31 (other departures).

[7]Atkinson [1990] argues that four percent annual real growth is the most realistic projection for the 1990s, "in order to maintain real [economic] growth and competitiveness." We chose to be more conservative. However, our results, though roughly twice as large, would not have been qualitatively different had we used Atkinson's number.

[8]Atkinson [1990], p. 428.

[9]Reconciliation with the numbers shown for year 7 of Figure 1.10 (the last year of driver expansion) proceeds as follows. For Physics: (884–815)/520 = 0.13; for Chemistry,: (1427–1314)/646 = 0.17; for Electrical Engineering: (1123–1144)/277 = –0.08.

[10]Massy and Wilger [1992].

Chapter 2
Doctoral Attainment Rates and Time-to-the-Degree

Estimating the probability distribution for achieving the doctorate has proved to be a formidable challenge.[1] The problem stems partly from the complexity of the behavioral processes involved and partly from data limitations: frequency data are collected by graduation cohort rather than matriculation cohort, dropout data are not systematically collected, and matriculants data are considered too unreliable to be made available on an institution-by-institution basis.

We constructed the model presented in this chapter in order to incorporate probabilities for doctorate attainment and time to the PhD degree in the doctorate supply-demand simulation described in Chapter 1. The three sections of this Chapter describe the model's structure and estimation procedure, present a detailed examination of doctoral attainment and time-to-degree for Physics, and extend the Physics results (in summary form) to the other 12 science and engineering fields included in our database. We shall refer to the structure as a "stochastic doctoral cohort model," for reasons that will become apparent.

I. Technical Description

Data

We obtained the following data by discipline for some 210 U.S. research and doctorate-granting institutions. The institution-level data were aggregated into ten segments using a statistical methodology described in Chapter 5. The data and model structure apply to a single segment or to pooled data for all the segments.

g_{Tk} *Frequency distribution for time-to-degree*, from the National Research Council (NRC),[2] for 5-year aggregations of graduation cohorts beginning in 1967 and ending in 1991 (i.e., 1967-71, 1972-76, 1977-81, 1982-86, and 1987-91), in total and broken down between U.S. citizens and non-citizens. Each frequency distribution consists of 19 years-to-degree cells, plus a cell for ≥20 years and an "unknown" cell. (The last two cells were sparsely populated, so we felt justified in dropping them.) The dataset provided two versions of each frequency distribution:

- *Registered time-to-degree (RTD):* the time a student actually was registered in graduate school before obtaining the doctorate, for all doctorate recipients. Time between the baccalaureate and first

graduate registration and "time off" during graduate study are excluded. These data seem to us to be the most relevant, given that we are going to use the model's results in the context of the academic production function.

- *Total time-to-degree (TTD):* the total time from bachelors to PhD degree, for all doctorate recipients. These data provide a useful contrast to the RTD data, as one can predict that the times to degree will be longer, the attrition rates higher, and the dispersion of graduation and dropout behavior greater.

n_t *Total fall enrollment of all graduate students (student census),* from CASPAR,[3] annually from 1972 to 1990, in total and broken down between U.S. citizens and others. We use the complete count of graduate students because we cannot distinguish between graduate students who intend to pursue a PhD from those with other intentions.

We could not obtain data on the number of dropouts or on the number of new students ("matriculants") by segment or citizenship. We do, however, have a limited time series consisting of aggregate matriculants data:

M_t annual data on the aggregate number of new students by discipline for the years 1982-90.

The number of matriculants for earlier time periods, for segments, and by citizenship will be approximated as described later.

Goal

The goal is to obtain consistent and efficient estimates for expected time to the doctoral degree and associated quantities, using the data described above. In particular, we want to estimate the transition probabilities needed by our simulation model:

$\Pr[G \in (t,t+\Delta t) \mid S@t]$: the probability that a student will graduate in the time interval $(t,t+\Delta t)$, given that he or she has been a student for t periods;

$\Pr[D \in (t,t+\Delta t) \mid S@t]$: the probability that a student will drop out in the time interval $(t,t+\Delta t)$, given that he or she has been a student for t periods.

Given the above, the probability that a student will stay in the program is

$$1-\Pr[G \in (t,t+\Delta t) \mid S@t]-\Pr[D \in (t,t+\Delta t) \mid S@t].$$

We believe the structure may vary by citizenship, segment, and discipline, so we wish to produce estimates on a disaggregative basis.

Model

We postulate that each entering student can be characterized by two *transition propensity functions*, each depending on a student-specific parameter γ:

$g[t \mid S@t, \gamma_g]$: propensity to graduate t periods after entering the program, given that he or she has remained a student to that point and behaves according to parameter γ_g;

$d[t \mid S@t, \gamma_d]$: propensity to drop out t periods after entering the program, given that he or she has remained a student to that point and behaves according to parameter γ_d.

The propensity functions are probability densities rather than probabilities. Our assumed structure is independent of the student's year of entry, which implies that the parameters are identical for all student cohorts. (Estimating the model for sub-intervals of time allows different parameter values, however.) The parameters γ_g and γ_d are assumed to vary over the student population as described later.

Experience suggests that the graduation propensity evolves through a series of phases, where a student can be said to:

gestate: a period of course-taking and other preparation, where the graduation propensity remains essentially at zero;

progress: a period of intense research on one's dissertation, where the graduation propensity rises over time and eventually reaches a maximum value characterized by γ_g;

sustain: a period where active research is mingled with other activities (including, for some, a full-time job), during which time the graduation propensity remains essentially constant;

erode: a period where the impetus for research is undermined and discouragement may set in, during which time the graduation propensity declines;

stagnate: a period where the student remains in the program but languishes at the lower graduation propensity reached at the end of the erosion phase.

While similar phases could be identified for the dropout propensity, data limitations led us to assume that $d[t \mid S@t, \gamma_d]$ is time-invariant. If data on dropouts were to become available, the model could be extended to make the dropout propensity vary according to the phases given above or a different set of

phases. The present dataset does not permit identification of the extended-model parameters, however.

The following structure maps these postulates into mathematical functions with the properties needed for parameter estimation: continuous first-order derivatives with respect to the parameters and integrability with respect to time.

$$
\begin{aligned}
g\left[t \middle| S@t, \gamma_g\right] &= 0, && 0 \le t < t_P \quad \text{(gestate)} \\
&= \frac{\gamma_g}{2}\left(1 - \cos\left[\frac{\pi(t - t_P)}{(t_E - t_P)}\right]\right) && t_P \le t < t_S \quad \text{(progress)} \\
&= \gamma_g, && t_S \le t < t_E \quad \text{(sustain)} \\
&= \frac{(1+r)}{2} + \frac{(1-r)}{2}\cos\left[\frac{\pi(t - t_E)}{(t_M - t_E)}\right] && t_E \le t < t_M \quad \text{(erode)} \\
&= \gamma_g r, && t > t_M \quad \text{(stagnate)}
\end{aligned}
\tag{2.1}
$$

$$
d\left[t \middle| S@t, \gamma_d\right] = \gamma_d, \qquad t \ge 0
$$

with additional parameters

t_P = beginning of the "progress" phase,

t_S = beginning of the "sustain" phase,

t_E = beginning of the "erode" phase,

t_M = beginning of the "stagnate" phase, and

r = ratio of the graduation propensity during the "stagnate" phase to that during the "sustain" phase.

There is a logical case for allowing r to vary among students, just like γ_g and γ_d. The model's mathematical structure would permit this, but the low incidence of graduation events at large t-values makes such a refinement impractical from the standpoint of identification.

Figure 2.1 interprets the parameters graphically by providing sample time shapes for the graduation and dropout propensities. It is apparent that the t-values are subject to the definitional constraints $0 \le t_P < t_S < t_E < t_M$, which have been incorporated into the model. We also included the additional constraints $t_M \le 20$ and $0 \le r \le 1$ to guard against instabilities stemming from weak identification.

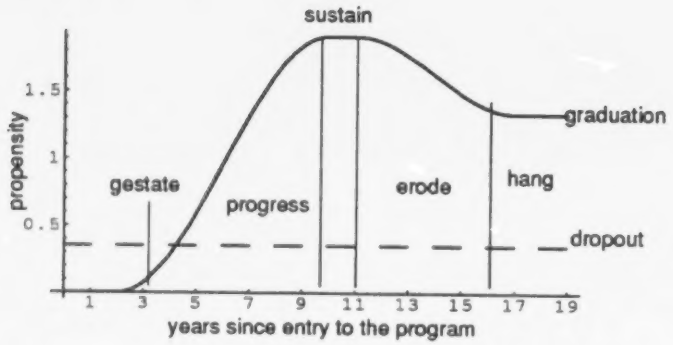


Figure 2.1
Sample Time Shape for An Individual's Graduation and Dropout Propensities

Our final postulates concern the variation of γ_g and γ_d over the student population. These parameters are not observable, so the model must be couched in terms of their frequency distributions.[4] We assume that γ_g and γ_d are distributed as independent gamma densities. The gamma density restricts the parameters to the positive real line, as required by the theory, and the result is tractable mathematically. We denote the parameters of the two gamma distributions as $\{\alpha_g, \beta_g\}$ and $\{\alpha_d, \beta_d\}$, where $E[\gamma] = \alpha\beta$ and $\text{var}[\gamma] = \alpha\beta^2$.

To trace the model's time evolution, we solve the following differential equation:

$$\frac{dh}{dt} = -\Big(g\big[t|S@t,\gamma_g\big] + d\big[t|S@t,\gamma_d\big]\Big)h$$

(2.2)
$$\int\frac{dh}{h} = -\int\Big(g\big[t|S@t,\gamma_g\big] + d\big[t|S@t,\gamma_d\big]\Big)dt$$

$$\Rightarrow h\big[t|\gamma_g,\gamma_d\big] = h_0\, e^{-\left(G\left[t|S@t,\gamma_g\right]+D\left[t|S@t,\gamma_d\right]\right)}$$

where $h_0 = 1$ is the initial condition and $G[\cdot]$ and $D[\cdot]$ are the cumulative conditional propensities for graduation and dropout. The new quantity $h[t \mid \gamma_g,\gamma_d]$ represents the probability of remaining in the program t periods after entering, given that one is behaving according to γ_g and γ_d. That is:

(2.3)
$$h\big[t\,|\,\gamma_g,\gamma_d\big] = \Pr\big[S@t\,|\,\gamma_g,\gamma_d\big]$$

The right-hand side of (2.2) is obtained by separately integrating the parts of (2.1) with respect to time, and then forming the definite integral for the whole time-line by taking the terminal value from each stage as the initial condition for the next one.

The probability density for graduating at t, conditional on γ_g and γ_d, can be written as:

$$g[t|\gamma_g,\gamma_d] = g[t|S@t,\gamma_g]\,h[t|\gamma_g,\gamma_d] \tag{2.4}$$

Next we integrate out the unobservable γ_g and γ_d to get the unconditional densities for graduating, dropping out, and remaining a student at t, as illustrated here for graduation:

$$g[t] = \int_0^{\bar{\gamma}}\int_0^{\bar{\gamma}} g[t|\gamma_g,\gamma_d]\,f[\gamma_g]\,f[\gamma_d]\,d\gamma_g\,d\gamma_d$$

This reduces to the following general form:

$$g[t] = k_{g0}[t]\left\{\int_0^{\bar{\gamma}} \gamma_g e^{k_{g3}[t]+k_{g2}[t]\gamma_g}\,f[\gamma_g]\,d\gamma_g\right\}\left\{\int_0^{\bar{\gamma}} e^{k_{d3}[t]\gamma_d}\,f[\gamma_d]\,d\gamma_d\right\} \tag{2.5}$$

which integrates to a closed form when, as assumed, the $f[\cdot]$ are gamma densities. The constants k are functions of t and the parameters, and $d[t]$ and $Pr[S@t]$ are obtained in a similar fashion.

The unconditional probabilities of graduating and dropping out in the interval beginning at t, which we denote by $Pr[G\in(t,t+\Delta t)]$ and $Pr[D\in(t,t+\Delta t)]$, are obtained from the definite integral of (2.5) and its $d[t]$ analog over the interval $(t,t+\Delta t)$. Then the conditional population probabilities for graduation and dropout—the transition probabilities which represent the goal of our analysis—are obtained by applying Bayes' Theorem:

$$\Pr[G\in(t,t+\Delta t)|\,S@t] = \frac{\Pr[G\in(t,t+\Delta t)]}{\Pr[S@t]}$$
$$\Pr[D\in(t,t+\Delta t)|\,S@t] = \frac{\Pr[D\in(t,t+\Delta t)]}{\Pr[S@t]} \tag{2.6}$$

The time-integrations needed to obtain closed-form expressions for the unconditional graduation and dropout probabilities elude us, but numerical approximations can be obtained easily.

In their discussion of PhD completion rates and time-to-degree, Bowen and Rudenstine describe a number of interpretive measures that can be calculated from our model. Their "truncated completion rate,"[5] the number of students of an entering cohort who have earned the doctorate within t years of graduate study, is equivalent to our $Pr[G\in(0,t)]$ when estimated from "total time-to-degree" data. Their "minimum completion rate" is equivalent to the same

quantity when one uses registered time-to-degree data for students doing all their work at the same institution. The asymptotic cumulative completion rate, the fraction of program entrants who eventually graduate, is simply Pr[G∈ (0,t)] as t goes to infinity. Finally, we can calculate their median time-to-degree by solving for t in:

$$\Pr[G \in (0,t)] = 0.5 \Pr[G \in (0,\infty)], \tag{2.7}$$

which is the time-point where the cumulative completion rate reaches 50% of its asymptotic value. Notice that our completion rates and times to degree take account of population heterogeneity in the graduation and dropout propensities.

Bowen and Rudenstine suggest that time-to-degree can be approximated by combining a normal distribution for "students who finish expeditiously" with "a series of three or four delays that impede the progress of other students."[6] Our model presents a different approach though the population-heterogeneity idea carries over. We do not try to identify specific "delay points," (such as admission to candidacy or thesis-proposal approval), since the needed data are not available; however, the graduation and dropout propensity heterogeneity and the several time-stages built into the model produce a similar result. Our model avoids the bias problem Bowen and Rudenstine describe.[7] They point out that a strong downward trend in matriculations will artificially inflate the time-to-degree statistics, because a disproportionate number of later-year graduates will have matriculated in earlier periods and taken a longer time to finish. Our model avoids the bias problem by modeling the population heterogeneity explicitly, so that each year's degree cohort contains the proper mix of fast and slow finishers regardless of the trend in matriculations.

Estimation

We estimate parameters by numerically minimizing the weighted sum of squared deviations between the data and the model's predictions. The predictions for time-to-degree frequency and student census are obtained from Pr[G∈ (t,t+Δt)], Pr[S@t], and the estimated number of matriculants for each time period. Let m[t]be a function (defined below) for calculating the matriculants in year t. Then the frequency and census predictions are:

$$\begin{aligned} g[T,k] &= m[T-k]\Pr[G \in (k,k+\Delta k)] \\ n[t] &= \sum_{k=0}^{k^*} m[t-k]\Pr[S@k] \end{aligned} \tag{2.8}$$

where k^*=25 approximates infinity for calculation purpose.

Obtaining Pr[G∈(*k*, *k*+Δ*k*)] by numerical integration using Mathematica's algorithm is too time-consuming for parameter estimation, since the function must be evaluated thousands of times. Hence we used the approximation:

$$\Pr\left[G \in (t, t+\Delta t) \middle| \gamma_g, \gamma_d\right] \approx \left\{G\left[t+\Delta t \middle| S@t, \gamma_g\right] - G\left[t \middle| S@t, \gamma_g\right]\right\} h\left[t \middle| \gamma_g, \gamma_d\right] \tag{2.9}$$

where the gammas can be integrated out as shown in (2.5) for the density functions. We then evaluate Pr[G∈ (*k*, *k*+Δ*k*)] by summing small values of Δt over the interval (*k*, *k*+Δ*k*). Experimentation indicated that, in the worst case, ten increments are sufficient to approximate the probability of graduating in a one-year interval to an accuracy of about 0.003, whereas the a single-increment error is ten times larger. Hence we designed the estimator to use increments of between 1 and 10, depending upon the error sensitivity for the time-value in question.

As stated at the outset, we have aggregate matriculants time series only for the years 1982-90, whereas the estimator requires matriculants estimates for k^* periods prior to the first graduation cohort (1967). Therefore, we added an auxiliary model for projecting matriculants. We chose a cubic equation as the best compromise between flexibility and parsimony in the number of parameters:

$$\mathrm{m}[t] = \mathrm{m}[t_0]\left\{b_1(t-t_0) + b_2(t-t_0)^2 + b_3(t-t_0)^3\right\} \tag{2.10}$$

where t_0=1986 and b_1, b_2, and b_3 are estimated along with the model's other parameters. Setting t_0 at the midpoint of the matriculants data series allows us to interpret m[t_0] as the average of the nine matriculants values. Hence m[t] equals the average when $t = t_0$, and deviates smoothly from the average as t varies. We know the grand-total m[t_0] for all the segments and citizenship classes, so we can estimate the fully pooled parameters without further difficulty.

The estimator minimizes the chi-square formed by combining the weighted sums of squared deviations between the actual and predicted values for the graduation-cohort frequencies, the student censuses, and the matriculants.

$$\chi^2 = w_1 \sum_T \sum_k \frac{(g_{Tk} - \mathrm{g}[T,k])^2}{\mathrm{g}[T,k]} + w_2 \sum_t \frac{(n_t - \mathrm{n}[t])^2}{\mathrm{n}[t]} + w_3 \sum_t \frac{(m_t - \mathrm{m}[t])^2}{\mathrm{m}[t]} \tag{2.11}$$

The weights should approximately equalize the three terms in accordance with generalized least squares practice. The weights are set twice: initially at one over the number of terms in the sum, and again, after the coarse-grain minimization using the pattern search procedure introduced below, to equalize the variances.

The latter process solves three simultaneous linear equations which equate the three objective-function terms and constrains the sum of the weights to one.

The minimum chi-square procedure is consistent and asymptotically efficient.[8] The error variance equals χ^2/df, and the parameters' asymptotic variance-covariance matrix equals the error variance times one-half the inverse of the matrix of second order cross-partial derivatives of (2.11) with respect to the parameters. The requirement that the first derivatives of the propensity function's time parameters be continuous, stated just before (2.1), insures that the second derivatives of (2.11) will be continuous as well, since (2.11) is based on the propensity-functions' time integrals.

The probability expressions comprising (2.11) are highly non-linear in the parameters, so we minimize the chi-square by numerical means. Thirteen parameters must be accommodated, some of which are subject to constraints. After experimentation, we settled on the Hook-Jeeves "pattern search" procedure[9] for coarse minimization and Mathematica's "FindMinimum" function[10] for fine-grained optimization after the pattern-search converged. The constraints were handled by penalizing the objective function according to $1000\,(1+x)^{100}$, where x is the amount by which the constrain is violated. Both the pattern search and Mathematica procedures handle this formulation with no difficulty, and tests showed that the process converges to a single point regardless of the starting values.

While the methods just described are sufficient for estimating the model's parameters from fully-pooled data, additional procedures are needed to differentiate between U. S. citizens and non-citizens and to disaggregate by segment. As stated earlier, the problem arises because we do not have matriculants data by citizenship category or segment. The problem is the same for both disaggregations, but since there are only two citizenship categories as opposed to ten segments, we use different strategies.

To disaggregate by citizenship, we simultaneously estimate separate parameter vectors for the two categories together with a new parameter, the proportion of $m[t_0]$ who are U. S. citizens. We designed the estimation program to constrain certain parameters to be equal for the two categories to save computation time, but we can run the estimator without these constraints if we wish.

To disaggregate by segment, we developed a procedure for allocating the aggregate $m[t_0]$ among the segments using information obtained from the model itself. First we estimate parameters for all segments combined, using pooled-segment results obtained as described in the previous paragraph. Then we reverse the chi-square minimization, so that the main parameters are fixed and

the $m_s[t_0]$, are treated as unknowns. The final step minimizes the error sum of squares for the segments' graduation frequencies and student censuses with respect to $m_s[t_0]$, for all s, subject to the constraint that the sum of the $m_s[t_0]$ equals the known aggregate $m[t_0]$. The $m_s[t_0]$ represent the sum of matriculants for U. S. citizens and non-citizens; the proportion of citizens for each segment will be determined during the segment-level parameter estimation.

II. Results for Physics

Figure 2.2 presents graphical representations of the model as fit to fully-pooled registered time-to-degree data for Physics and Astronomy, and the underlying parameter estimates are presented in first column of Table 1. The model fits well, as can be seen from the Figure's upper panels. The first panel superimposes the model's predictions for graduation-frequency on the normalized data graduation-frequency points. The second does the same for the actual and predicted census figures, and the third shows actual and predicted matriculants. Notice that the predicted matriculants curve goes through the average matriculants value, as it must, but lies below the weight of the data-points for small matriculants values—this is required in order to optimize the fit of the census and frequency data, which also key off the matriculants parameters.

The left-hand panel in Figure 2.2's middle tier graphs the upward progress and eventual erosion of graduation propensity, as depicted by the solid curve, and dropout propensity, as depicted by the dashed straight line.[11] The graphs are based on a hypothetical student with gamma-values at the medians of the two heterogeneity distributions. Apparently, propensity peaks at around 11 years, the exact value being given by the "begin-sustain" and "begin-erode" parameters in the first column of Table 2.1. "Erosion" proceeds to a level, reached just after year 19, equal to 40% of the peak. The gestation period, represented by the "begin-progress" coefficient, is slightly longer than 2 years.

The standard errors of the time coefficient estimates are quite small—so small that one must look for a reason. The values for "begin-sustain" and "begin-erode" are of the order of 10^{-6}, which is an artifact of the constraint that prevents "begin-erode" from coming out less than "begin-sustain." The estimates are pinned against the constraint, and the strong curvature of the objective function drives down their standard errors. We suspect that a price must be paid in terms of higher-order effects, however, which may account for the relatively large standard errors of the propensities coefficients. We see, in fact, that none of the propensities coefficients are statistically significant, although the "graduate-shape" coefficient approaches significance at the 90% level.

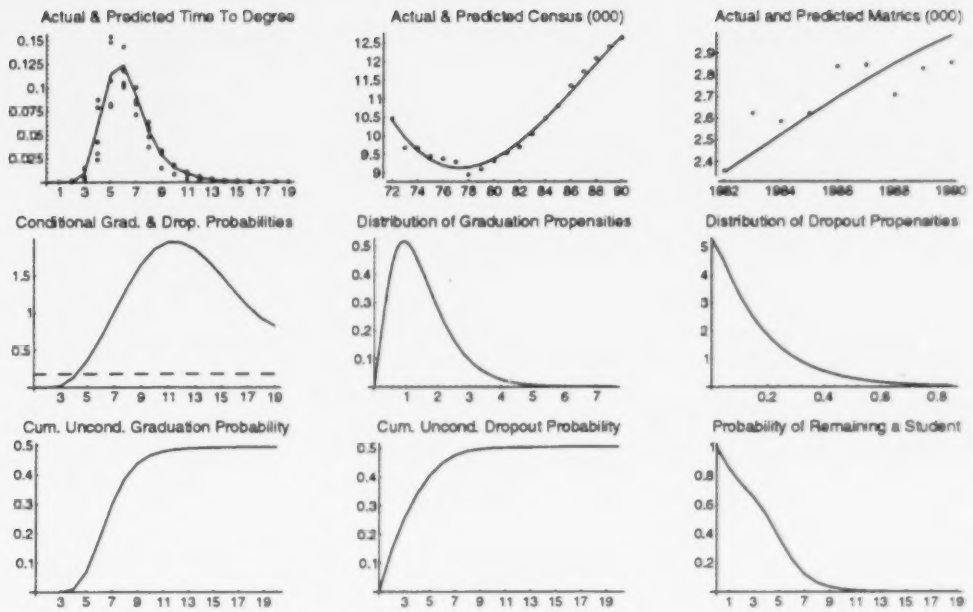

Actual & Predicted Time To Degree
Actual & Predicted Census (000)
Actual and Predicted Matrics (000)
Conditional Grad. & Drop. Probabilities
Distribution of Graduation Propensities
Distribution of Dropout Propensities
Cum. Uncond. Graduation Probability
Cum. Uncond. Dropout Probability
Probability of Remaining a Student

Figure 2.2
Registered Time to Degree 12 Variable Estimation
Physics and Astronomy: All Segments Combined
1967-1990

Note: the caption in the left-hand middle panel should read "Conditional Grad. and Drop Propensities" (not "Conditional Grad. and Drop Probabilities").

Table 2.1
Parameter Estimates
Physics and Astronomy: All Segments Pooled
1967-1991

	RTDTotal		TTDTotal
	12 vars	9 vars	9 vars
Time factors			
begin-progress	2.057	2.051	1.464
	(0.120)	(0.101)	(0.287)
begin-sustain	10.789	11.418	10.905
	(0.000)	(1.575)	(1.475)
begin-erode	10.789	18.000	18.000
	(0.000)	(na)	(na)
begin-hang	19.380	19.000	19.000
	(0.884)	(na)	(na)
Propensities			
erode-floor	0.403	1.000	1.000
	(1.786)	(na)	(na)
graduate-shape	2.640	2.576	4.826
	(1.373)	(0.401)	(0.615)
graduate-scale	0.573	0.661	0.148
	(0.414)	(0.247)	(0.039)
dropout-shape	1.044	1.601	0.654
	(2.262)	(0.255)	(0.035)
dropout-scale	0.163	0.097	0.375
	(0.451)	(0.018)	(0.029)
Matriculants			
linear	83.111	77.903	80.020
	(0.313)	(7.871)	(5.206)
quadratic (x10)	-1.874	-2.707	-2.936
	(0.515)	(1.202)	(0.773)
cubic (x1000)	-0.274	-0.309	-0.307
	(0.027)	(0.046)	(0.029)
Sum of squared errors	151.5	148.0	136.3
Degrees of freedom	111	114	114
R-squared	91.4%	91.6%	93.0%

Note: the figures in parentheses are the standard errors of the coefficients;
"0.000" indicates that the estimate was imaginary.

Given these results, it seemed natural to disable the "erode" phase of the model by predetermining "erode-floor" at 1.0, which makes the values of "begin-erode" and "begin-hang" irrelevant. (We set the last two parameters at 18 and 19; however, their values do not affect the model's predictions.) The 9-variable estimates are shown in the second column of Table 2.2. The gestation period is

virtually unchanged, and the sustain period begins only slightly later. The standard error of "begin-sustain" now is a reasonable 1.575; both it and the "begin-progress" coefficient are highly significant. The last line of the table shows no loss in explanatory power. The 9-variable model actually appears to fit slightly better, but the small difference is due to variations in the objective function weights and the precision of the numerical minimization.

Moving on down the columns of Table 2.1, we see that the graduation propensity coefficients do not change much between the 12-variable and 9-variable runs, and that the latter are significant statistically. The second panel in Figure 2.2's middle tier graphs the gamma distribution produced by the 12-variable coefficients, and the 9-variable distribution is virtually identical. The dropout coefficients do change: "shape" grows materially while "scale" shrinks. The 12-variable dropout propensity distribution, shown to the right of the one for graduation propensities, approaches an exponential. The 9-variable distribution (not shown), however, rises to a peak at about 0.05 before falling away. Finally, the matriculants coefficients do not vary materially between the 12-variable and 9-variable runs.

The three panels in Figure 2.2's bottom tier depict the cumulative unconditional graduation and dropout probabilities and the unconditional probability of remaining a student. The graduation probability becomes asymptotic to 0.494 and the dropout probability to 0.506, by which point the probability of remaining a student has gone to zero. The figures imply that just under fifty percent of entering students will eventually graduate. The 9-variable curves look almost exactly the same.

We estimated both models for total-time-to-degree (TTD) data, but show only the 9-variable result. For the 12-variable case, "erode-floor" was estimated at 1.0, which makes "begin-erode" and "begin-hang" impossible to identify. The standard errors of these coefficients were complex, which is an indication of degeneracy. The other 12-variable coefficients were virtually identical to the 9-variable ones shown in the table. The "begin-progress" and "begin-sustain" coefficients are smaller than their RTD counterparts, a surprising result but, for the latter coefficient, one that does not have statistical significance. The differences between the matriculants coefficients also lack significance.

The median time-to-degree for the TTD run, about 6.2 years, is shorter than the ones reported by Tuckman, Coyle, and Bae for 1967 and 1986: 6.34 years and 7.07 years, respectively.[12] Our figure should represent something of an average of theirs: 6.7 years versus our 6.2 years. We suspect the difference stems from the rise of foreign doctoral students, which as we shall see in Table 2.6 have a shorter

time-to-degree, and the censoring associated with using raw time-to-degree statistics. It would appear that our model picks up the foreign shift more quickly than the raw statistics do. Our time-to-degree results are also smaller than the figures for time from the bachelors to the doctorate, 6.5 years for 1960-1969, rising to 6.9 years for the 1970s, and 7.3 years for the 1980s;[13] however, one would expect time from first graduate registration (our figures) to be smaller than the time from the baccalaureate.

Table 2.2
Summary Statistics
Physics and Astronomy: All Segments
1967-1991

	RTD 12 yars	RTD 9 yars	TTD 9 yars
Graduation probability	49.4%	48.6%	44.8%
Exp. time to degree:			
10% of cohort	3.78	3.77	3.77
25% of cohort	4.54	4.53	4.80
50% of cohort	5.55	5.53	6.16
75% of cohort	6.77	6.75	7.79
90% of cohort	8.17	8.13	9.62
Graduation propensity:			
median	1.33	1.49	0.66
mean	1.51	1.70	0.71
coef. of variation	0.62	0.62	0.46
Dropout propensity:			
median	0.12	0.12	0.14
mean	0.17	0.15	0.25
coef. of variation	2.91	2.62	2.11
R-squared	91.4%	91.6%	93.0%

The propensities coefficients differ by amounts that are significant both statistically and materially in terms of interpretation. To understand the differences, we examine certain summary statistics computed from the model and presented in Table 2.2. The first row reports the fraction of entering students who are expected to graduate—that is, the asymptote of the unconditional cumulative graduation curve shown in Figure 2.2. As indicated earlier, we estimate that 49.4% of entering students will attain the doctorate eventually. The next five figures give the time required for the cumulative graduation probability to reach the indicated percentage of its asymptotic value. For example, ten percent of graduates will get their degrees in 3.78 years, ninety percent will have done so in 8.17 years, and the median time-to-degree is 5.55 years. The median, mean, and coefficient of variation (mean/standard deviation) of the graduation propensity distribution are given next, followed by the same quantities for the dropout propensity distribution. The value of R-squared is again provided at the bottom of the table.

We now see that, as expected, the expected time-to-degree is longer for TTD than for RTD. TTD's shorter "begin-sustain" interval is swamped by its substantially smaller graduation propensity values, which are called out by the mean and median of the propensity distribution. These, together with the slightly

larger figures for dropout propensity, also account for the smaller asymptotic graduation probability.

Bowen and Rudenstine report the (asymptotic) cumulative probability of gaining a physics doctorate at 71%, based on "elapsed time-to-degree" (ETD) data for eight research universities between 1967 and 1971.[14] (ETD represents the time between first graduate registration and degree, including "time off" during graduate study.) Their 71% is considerably larger than our 45% to 50%, based on RTD and TTD, which should bracket ETD. Doubtless much of the difference is due to their much narrower institutional sample and shorter time period. Indeed, the cumulative completion rate for physics and mathematics combined did drop from 66.9% to 64.6% between the 1967-71 period and the 1972-76 period, suggesting a downward trend. It seems possible, however, that Bowen and Rudenstine's figures suffer from the bias discussed earlier, which arises from the combination of censured data and non-stationary matriculations.

Turning now to the median time-to-degree, Bowen and Rudenstine report 6.4 years, for Physics, based on ETD data for all universities between 1967 and 1971.[15] We found the median to be about 5.5 for RTD and 6.2 for TTD, for all universities between 1967 and 1990 (Table 2.2). Our somewhat shorter times suggest that efforts to speed up time-to-degree may be bearing fruit.

Table 2.3 gives results for the allocation of matriculants to segments. To simplify the presentation in this chapter, we grouped the segments into two categories for each type of control: the two most elite segments (group A), and the remainder (group B). The table compares the average matriculation predictions for the segment groups with allocations based on the group's proportion of graduate enrollees. The largest percentage correction occurs in Segment A, where the model predicts 4.9% more matriculations than would have been obtained with proportionate allocation. The correction is at the expense of Segment D, but the percentage difference in this larger segment is modest. The figures are quite close for the other two segments.

Table 2.3
Estimated and Proportional Matriculants & Number of Degrees, by Segment
RTD: Physics and Astronomy

Seg. no.	No. of. degrees	Est. mats.	Prop. mats.	% diff.
Private				
A	5,542	387	369	4.9%
B	6,124	506	506	-0.1%
Public				
C	4,009	413	413	0.1%
D	12,530	1,391	1,409	-1.3%

Table 2.4 presents summary results based on parameter estimates for the four segments. It is immediately apparent that the asymptotic graduation probability

Table 2.4
Summary Results by Segment Groupings
RTD: Physics and Astronomy

	Private		Public	
	A	B	A	B
Graduation probability	58.3%	56.3%	53.3%	51.7%
Exp. years to grad.				
10% of cohort	3.66	3.44	3.94	3.90
25% of cohort	4.30	4.24	4.72	4.71
50% of cohort	5.14	5.29	5.73	5.79
75% of cohort	6.13	6.58	6.96	7.11
90% of cohort	7.22	8.05	8.34	8.62
R-squared	82.6%	89.0%	89.2%	93.0%

declines with segment: from 58.3% for Segment A to 51.7% for Segment D. Moreover, the private sectors' probabilities dominate those in the public sector. Segment A's probability is about 10% greater than Segment C's (58.3/53.3), and the disparity between Segments B and D is about the same. Looking to the expected time to graduation, we see that students are more likely to graduate quickly in private-sector institutions than in public ones. Segment A also produces somewhat quicker graduations than Segment B, but the two public-sector segments exhibit little difference.

We note that the segment-level asymptotic graduation probabilities are all greater than the one for the pooled run (Table 2.2, RTD 9 vars). The numbers of matriculants and the numbers of graduate students are conserved in the segment-level runs, so there has been no leakage of numbers out of the system. For the present we merely note this as an anomaly, which should be a subject for further study.

Table 2.5 presents summary statistics for four overlapping 10-year time intervals, covering the period from 1965 to 1990. Each interval contains two graduation cohort frequency distributions: for example, 1965-75 uses the 1967 and 1972 cohorts. All intervals use the same matriculants' series (1982-90), though the earlier periods involve more backward extrapolation.

The results suggest that the asymptotic graduation probability and the expected time to the doctorate may have increased during the last 25 years. The graduation-probability increase occurred during the past decade, from the 40-50% range to more than 70%. (The 1970s seem to display a slight dip.) The time-to-degree has been creeping up steadily. For example, the median years to

Table 2.5
Results by Ten-Year Period: 1965-1991
RTD: Physics and Astronomy; All Segments

	1965-75	1970-80	1975-85	1980-90
Graduation probability	53.7%	41.0%	50.4%	72.8%
Exp. years to grad.				
10% of graduates	3.45	3.72	3.92	4.10
25% of graduates	4.24	4.46	4.69	4.88
50% of graduates	5.26	5.44	5.70	5.91
75% of graduates	6.47	6.64	6.94	7.18
90% of graduates	7.82	8.02	8.41	8.67
R-squared	91.6%	89.0%	90.1%	96.4%

graduation increased from 5.26 in 1965-75 to 5.44 in 1970-80, and then to 5.70 in 1975-85 and 5.91 in 1980-90. The other percentiles show a similar pattern.

Table 2.6 presents pooled-segment results for U. S. citizens and non-citizens. The comparison is quite striking. The asymptotic graduation probability for visa-holders is only two-thirds as large as that for citizens: 33% versus 53%. On the other hand, those visa-holders who do obtain their degrees will do so fairly quickly: the median time to graduation is only about 4.5 years compared to 5.5 years for their U .S. colleagues. The timing distribution is sharply truncated for the non-citizens, with graduates requiring five years to get their degrees. The distribution for citizens shows the usual long tail, with ten percent of graduates taking more than eight years. While we have not calculated the statistical significance of these deviations, the differences in the underlying parameters run to as much as several times their standard errors. The value of R-squared, which applies to both citizenship categories, is a very respectable 97 percent.

Table 2.6
U. S. Citizens and Visa Holders
RTD: Physics and Astronomy; All Segments
1965-1980

	U.S.	Visa
Graduation probability	53.9%	33.2%
Exp. years to grad.		
10% of graduates	3.74	3.59
25% of graduates	4.49	4.09
50% of graduates	5.49	4.46
75% of graduates	6.72	4.79
90% of graduates	8.13	4.74
R-squared	97.2%	

Table 2.7 gives the conditional probabilities for graduation and dropout, which provided our original motivation for developing the model. Each figure represents the probability of a transition away from student status during the year, given that the person was a student at the beginning of the year. For example, new students have no chance of graduating during their first year, but 10.8% of the U. S. citizens and 18.5% of

visa-holders are likely to drop out. For each group, the probability of remaining a student is one minus the sum of the two transition probabilities.

Table 2.7
Transition Probabilities
U. S. Citizens and Visa Holders
RTD: Physics and Astronomy; All Segments
1965-1980

Years in program	Graduation probability		Dropout probability		Continuation probability	
	U.S.	Visa	U.S.	Visa	U.S.	Visa
1	0.0%	0.0%	10.8%	18.5%	89.2%	81.5%
2	0.0%	0.1%	10.4%	17.6%	89.6%	82.3%
3	1.4%	2.4%	10.0%	16.8%	88.6%	80.8%
4	9.4%	7.9%	9.3%	15.7%	81.3%	76.4%
5	21.6%	15.6%	8.5%	14.4%	69.9%	70.0%
6	32.3%	23.7%	7.6%	13.2%	60.1%	63.1%
7	38.7%	30.9%	7.0%	12.1%	54.3%	57.0%
8	41.2%	36.4%	6.7%	11.2%	52.1%	52.4%
9	41.1%	39.9%	6.5%	10.5%	52.4%	49.6%
10	39.6%	41.7%	6.4%	10.0%	54.0%	48.3%
11	37.4%	42.0%	6.3%	9.7%	56.3%	48.3%
12	34.9%	41.1%	6.3%	9.4%	58.8%	49.5%
13	32.3%	39.4%	6.2%	9.3%	61.5%	51.3%
14	29.7%	37.0%	6.2%	9.2%	64.1%	53.8%
15	27.2%	34.3%	6.1%	9.1%	66.7%	56.6%
16	24.8%	31.9%	6.1%	9.0%	69.1%	59.1%
17	22.6%	29.8%	6.1%	8.9%	71.3%	61.3%
18	20.4%	27.9%	6.0%	8.8%	73.6%	63.3%
19	18.4%	26.3%	6.0%	8.7%	75.6%	65.0%
20	16.7%	24.9%	5.9%	8.6%	77.4%	66.5%

The graduation probabilities rise steadily until the ninth or tenth year, after which they decline moderately. The dropout probabilities decline steadily; they become smaller than the graduation probabilities at around the fourth or fifth year. The probability of remaining a student reaches a minimum between the eighth and tenth year and then rises modestly. One should be careful when interpreting the outyears' probabilities, however, since the data contain few observations for student tenures greater than eight or ten. Moreover, our assumption of a time-invariant dropout propensity subject to population heterogeneity guarantees that the population dropout transition probability will decline monotonically. As noted earlier, the time-invariance assumption arose as a matter of necessity given the absence of dropout data, not as a judgment about behavior.

III. Results for All Fields

Having established the model's efficacy for Physics, we proceeded to run it on data for the other fields included in our science and engineering dataset. The dataset consists of thirteen fields. Our discussion focuses mainly on the aggregate results for the thirteen fields; however, the last section does describe certain attributes of the segment-by-segment results used to power the simulation.

Appendix Table 2-A.1 through 2-A.3 report the model's structural parameters and their standard errors. The "begin-erode," "begin-hang," and "erode-floor" parameters were set at 17. 0, 18.0, and 1.0, respectively, thus suppressing propensity erosion for purposes of simplicity. Standard errors equal to "0" and "na" indicate that the parameter in question has been preset in order to mitigate estimation problems. Standard errors equal to "im" indicate that the error estimate was imaginary: this occurs occasionally due to numerical inaccuracies, especially involving parameters that are pinned at their constraint-values. These problems require us to interpret the standard-error estimates cautiously. The model appears well-behaved despite the occasional anomalies.

Table 2.8 presents the summary statistics for all thirteen fields. Results are given separately for U.S. citizens and visa holders ("US" and "Visa"). Each set consists of the fraction of matriculants predicted to attain the degree ("Graduation probability") and of the registered time in years required to attain the degree for the 10th, 25th, 50th, 75th, and 90th percentile of candidates who do in fact graduate. The fraction of 1985 matriculants estimated to have been U.S. citizens and the weighted average graduation probability (using the matriculation fractions as weights) also are presented. The fields are arrayed in order of their average graduation probability.

Matriculations

Our matriculation data series does not distinguish between citizens and visa-holders, but the model provides an estimate of the U.S. percentage and the direction of its trend as of 1985. While we can approximate the trend's time derivative, the simple dichotomy "down" versus (approximately) "flat" will suffice for present purposes. The U.S. percentage ranges from a high of about 92% (trend flat) for Psychology to a low of 46% for Economics (trend down). The U.S. percentage runs from the mid-fifties to the mid-sixties for most fields; however, Geosciences joins Psychology on the high side (trend down; perhaps

Table 2.8
Time-to-Doctorate Model: Summary Statistics
All Segments

	Physics		Biology		Chemistry		Geosciences		Chem. Eng.		Economics		Psychology	
	US	Visa	US	Visa	US	Visa	US	Visa	US	Visa	US	Visa	US	Visa
Graduation probability	53.7%	33.2%	35.6%	37.9%	38.4%	30.1%	25.3%	28.2%	28.2%	20.0%	26.2%	16.8%	18.5%	7.1%
Exp. years to grad.														
10% of graduates	3.74	3.59	3.46	3.49	3.14	3.05	3.70	3.60	3.06	2.69	3.09	2.63	3.32	3.01
25% of graduates	4.49	4.09	4.27	4.39	3.74	2.80	4.47	4.28	3.69	2.63	3.94	3.07	4.20	3.67
50% of graduates	5.49	4.46	5.50	5.80	4.55	3.64	5.46	4.95	4.56	4.09	5.12	3.91	5.38	na
75% of graduates	6.72	4.79	7.38	8.11	5.54	4.71	6.62	5.56	5.64	4.59	6.67	4.69	6.90	na
90% of graduates	8.13	4.74	10.20	13.64	6.72	5.50	7.90	5.87	6.91	5.02	8.57	5.11	8.78	na
Fraction 1985 mats US citizens	53.5%		84.2%		68.0%		71.4%		56.2%		46.2%		92.4%	
Direction of change	flat		down		down		down		down		down		flat	
Average graduation probability	44.2%		36.0%		35.7%		26.1%		24.6%		21.1%		17.6%	

	Computer Scl.		Math		Mech. Eng.		Elect. Eng.		Civil Eng.		Indust. Eng.		Average	
	US	Visa	US	Visa	US	Visa	US	Visa	US	Visa	US	Visa	US	Visa
Graduation probability	12.2%	28.8%	20.1%	12.2%	16.8%	15.9%	12.4%	17.4%	5.6%	10.8%	4.8%	12.7%	22.9%	20.9%
Exp. years to grad.														
10% of graduates	4.03	4.00	3.14	2.71	3.15	3.13	3.25	3.37	3.06	3.32	2.92	3.43	3.31	3.23
25% of graduates	5.00	5.12	3.91	3.73	3.97	3.88	4.04	4.33	3.87	4.01	3.82	4.62	4.11	3.89
50% of graduates	6.35	6.92	4.95	3.30	5.07	4.94	5.14	5.70	4.97	5.37	5.12	6.76	5.21	4.99
75% of graduates	8.13	na	6.24	3.99	6.43	6.11	6.54	8.51	6.33	na	6.95	na	6.62	5.67
90% of graduates	10.41	na	7.75	4.40	7.98	7.24	8.21	na	7.86	na	9.24	na	8.36	6.44
Fraction 1985 mats US citizens	68.0%		65.5%		51.5%		62.7%		57.3%		67.9%		65.0%	
Direction of change	flat		flat		flat		flat		down		flat		na	
Average graduation probability	17.5%		17.4%		16.4%		14.3%		7.8%		7.3%		22.0%	

Geosciences is just catching on overseas), and Mechanical Engineering joins Economics on the low side (trend flat).

Graduation Probabilities

The graduation probabilities range from a high of 44% for Physics to a low of just over 7% for Industrial Engineering. The overall mean (weighting all fields equally) is 22.0%. Recall that we use the entire population of graduate students, regardless of their intention. Therefore the graduation probabilities will be lower in those fields where a large number of students undertake graduate work without the intention of completing a PhD. The model predicts that only about 2 of 9 graduate matriculants will eventually attain the PhD degree. This figure takes candidates still in their program at the time of data collection fully into account. The asymptotic probability estimate extrapolates the probability curve to its limit; the probability curve is not subject to truncation bias. On the other hand, our model remains vulnerable to errors in the matriculations data series. Overstatements in that series would reduce the graduation probabilities, but would not materially affect the model in other ways.

Time-to-degree

While the asymptotic graduation probability is very important for explaining PhD. production, it tells only half the story. How long does it take to get a degree? How does time-to-degree vary among degree recipients? We now turn to the distribution of registered time-to-degree: the number of years a student is actually registered between entry to graduate school and his or her emergence with the doctorate. The requisite information is contained in the summary statistics of Table 2.8, for registered time-to-degree (RTD).

Median (50th percentile) RTD ranges from a high of 6.9 years for visa-holding matriculants in Computer Science to a low of 3.3 years for visa-holders in Mathematics. For U.S. citizens, the high is 6.4 years (Computer Science) and the low is 4.5 years (Chemical Engineering). We can only speculate on the reasons that these categories demonstrate extreme behavior. Perhaps foreign candidates in math are better prepared as undergraduates, while those in computer science are less well versed in computing. (Computer Science, however, takes a long time for U.S. students, too.) We could not compute the median time-to-degree for visa-holders in Psychology—probably because, with 92.4% of matriculants being U.S. citizens, no enough cases exist for stability.

The median RTD tend to cluster around 4.5 to 5.5 years. (The mean across fields and citizenship categories is 5.1 years.) Recall that this is registered time-to-degree: time spent in unregistered status—teaching at another school, for

example—is not included. The total TTD will be somewhat longer than the registered RTD. We have the data on total time-to-degree but have not had time to process it for fields other than Physics.

The model predicts considerable variation in time-to-degree within each field as well as across fields. In Physics, for example, the first 10% of U.S. matriculants graduate in 3.7 years, almost two years faster than the median of 5.5 years. The 25th percentile posts a time of 4.5 years, the 75th percentile posts 6.7 years, and it takes more than 8 years of registered study to graduate 90% of eventual degree recipients. The figures are materially lower for Physics visa-holders.

Looking at the US category, where the statistics appear stable, we see that two fields stand out as having a particularly long "tail:" Computer Science, where 10.4 years is required to graduate 90% of degree attainers, and Biology, where the figure is 10.2 years. Chemistry and Chemical Engineering do particularly well on the "lingering student" problem. For them, the 90th percentile graduates in only 6.7 and 6.2 years, respectively. For most other fields, the figure is fairly close to 8 years.

The time-to-degree figures for the tenth percentile are much more tightly clustered, as would be expected. They run from about 3.1 years for most fields to a high of just over 3.5 years for Physics, Geosciences, and Biology. Apparently, the thesis work in these fields is more demanding in terms of minimum time requirements. Visa-holders show greater variability from 2.3 years (Economics) to 3.6 years (Geosciences)—perhaps reflecting differences in undergraduate preparation.

Relation between graduation probability and time-to-degree

Scanning table 2.8 suggests a relation between graduation probability and time-to-degree, and closer inspection confirms that this is indeed the case. Table 2.9 displays a two-by-two comparison of the relative magnitudes of the

Table 2.9

Graduation Rate v. Median time-to-degree

	Median time to degree			
Graduation rate	US>Visa	US<Visa	Unknown	Total
US>Visa	6	0	1	7
US<Visa	1	5	0	6
Total	7	5	1	13

graduation probabilities, and the median time-to-degree, for U.S. citizens and visa-holders. The table shows a very powerful relationship between the two variables. Eleven of the twelve cases for which data exist fall on the diagonal. The resulting contingency table has a chi-square of 8.6 with one degree of freedom, which is highly significant.

The strong correlation between graduation probability and time-to-degree is consistent with the idea that students with higher aptitudes and greater motivation ("graduation propensity" in the model's vernacular) graduate first. Therefore, RTD lengthens as graduation rates go up. The approximate difference from the tenth to the fiftieth percentile is a little less than two years, whereas the difference between the fiftieth and ninetieth percentile is more like three years. All of this comports with common sense, and we are pleased that the model produces such believable results.

Graduation Probability by Citizenship Category

Table 2.10 presents summary statistics on the relationship between graduation probability and citizenship category, with the effect of field removed. The first two columns show the two graduation probabilities from Table 2.8. Column three gives the ratio of the visa-holder probability to the U.S.-citizen probability, and Table 2.10 is arranged according to this statistic.

Industrial engineering presents the greatest advantage of foreign over U.S. attainment rates: the visa-holder graduation rate is 2.65 times the rate for U.S. citizens. Psychology presents the greatest advantage for U.S. citizens, who graduate at 2.6 times the rate of their foreign colleagues (1 / 0.38 = 2.6). On balance, the fields are about equally divided, with foreign students showing higher attainment in six of the thirteen, and U.S. students gaining the advantage in the remaining seven fields. The distribution of fields presents no particular pattern in terms of field type (science or engineering), average graduation probability ("Ave. Pr."), or trend in the fraction of visa holders ("Trend").

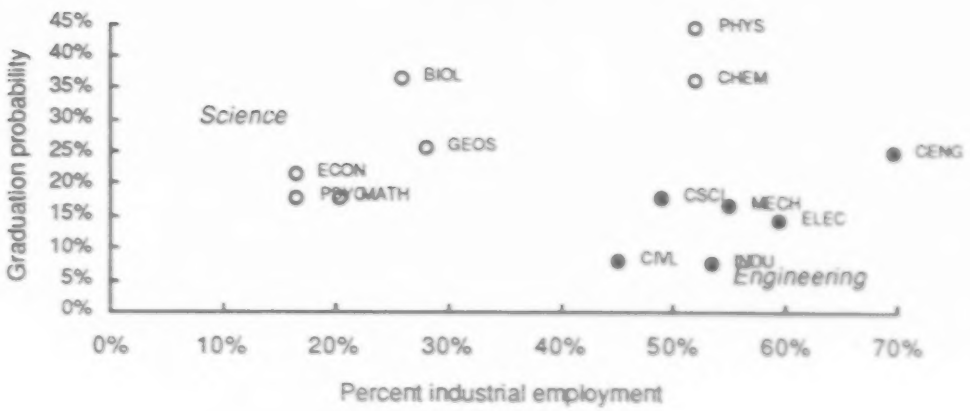
Graduation Probabilities and Industrial Opportunity

Table 2.10 also includes the weighted average of the graduation probability and a new variable, the percentage of Science and Engineering PhDs working in the U.S. who were employed in industrial, as opposed to educational, government, and non-profit, jobs in 1991.[16] We had thought the industrial percentage might help explain the ratio of foreign to U.S. graduation probabilities, but it is apparent that no such relation exists. These data do shed light, however, on the weighted-average graduation probability.

Fields with higher industrial employment percentages may generally be expected to offer higher compensation for PhDs than fields with lower industrial employment utilization. Industrial salaries generally are higher than those in universities and government laboratories, and these salaries apply to a larger proportion of PhDs in high-utilization than low-utilization fields. Moreover, the high-utilization fields also would be expected to offer more lucrative consulting opportunities for university faculty. Hence we expect that the high industrial-utilization fields will offer greater incentives to complete the doctorate than low-utilization fields, other things being equal.[17]

A glance at the graduate-probability and industrial-employment columns of Table 2.10 shows that the above hypothesis is too simple: the two variables appear to have no relationship. The situation clarifies dramatically, however, if field type is considered. Figure 2.3 shows the scatter-plot of percent industrial PhD utilization and weighted average graduation probability for two field categories—which we shall call "Science" and "Engineering." The assignments

Figure 2.3. Graduation Probability v. Percent Industrial Employment



are clear-cut except for Computer Science, which we believe should be assigned to Engineering because of its strong affiliations with the computer hardware and software industries.

Figure 2.3 reveals a strong relationship between industrial employment utilization of PhDs and graduation probability once field type is taken into account. Graduation rates for science are higher than those for engineering, other things being equal. We believe this stems from better opportunities for "all-but-thesis" students in engineering, where the contact is closer to industry

Table 2.10
U.S. and Visa Graduation Probabilities and Percent of Doctorates Emloyed in the Industrial Sector

	US	Visa	Visa/US	Ave. pr.	% ind emp.
Industrial Engineering	4.8%	12.7%	2.65	7.3%	53.5%
Computer Science	12.2%	28.8%	2.36	17.5%	49.1%
Civil Engineering	5.6%	10.8%	1.93	7.8%	45.2%
Electrical Engineering	12.4%	17.4%	1.40	14.3%	59.5%
Geosciences	25.3%	28.2%	1.11	16.2%	28.1%
Biology	36.0%	38.0%	1.06	36.3%	26.0%
Mechanical Engineering	16.8%	15.9%	0.95	16.4%	55.0%
Chemistry	38.4%	30.1%	0.78	35.7%	52.0%
Chemical Engineering	28.2%	20.0%	0.71	24.6%	69.8%
Economics	26.2%	16.8%	0.64	21.1%	16.6%
Physics	53.7%	33.2%	0.62	44.2%	52.0%
Math	20.1%	12.2%	0.61	17.4%	20.4%
Psychology	18.5%	7.1%	0.38	17.6%	16.6%

than in science. There are more engineering than science jobs for people with partial training— people who don't need to be a "certified expert" (PhD) to find good professional employment.

The hypothesized positive effect of industrial utilization on graduation probability asserts itself once field type is taken into account. Each of the field clusters in Figure 2.3 shows an upward trend of between one-half and two-thirds of a percentage point in graduation probability for every point in industrial utilization. It appears that a stronger industrial market for PhDs does indeed provide a powerful incentive for graduation.

Results by segment

Estimating the model separately by segment group for each field produces some interesting patterns. Table 2.11 shows the graduation probabilities by segment group. The general rule was to pool the two most elite segments and then the remaining segments for each type of control. In the case of Physics, for example, "Private high" refers to segments 1 and 2, "Private low" to segments 3 and 4, "Public high" to segments 5 and 6, and "Public low" to segments 7 though 10. The "All segments" line was taken from Table 2.8 for purposes of comparison. The averages for U.S. citizens and visa holders (all fields weighted equally), and the unweighted average of these averages, also are provided. We note that, in a few cases, the "All segments" graduation probability lies outside the range of the segment probabilities: this seems to result from non-linearities in the estimator.

The average probabilities show a persistent tendency for the less elite segments to graduate higher fractions of their matriculants than the more elite ones. This relationship occurs in 23 of the 36 individual comparisons, a deviation of about 1.7 sigma from the 18 cases that would be expected by chance. Of the 23 cases, 14 represent visa-holders, which suggests that segment status makes more of a difference for that population than for U.S. citizens. Indeed, the low segments exhibit the larger graduation probability in 14 of the 18 "Visa" comparisons but only 9 of 18 "U.S." comparisons. The low segments' advantage is approximately equally distributed between the public and private sectors—14 of 20 cases (70%) for the public segments, compared to 10 of 16 cases (62.5%) for the private ones. There appears to be no relation to field category. On balance, then, we conclude that visa-holders graduate at higher-than-average rates in the lower segments, regardless of type of control.

Table 2.11.
Graduation Probabilities by Segment

	Physics		Biology		Chemistry		Geosciences		Chem. Eng.		Economics		Psychology	
	US	Visa	US	Visa	US	Visa	US	Visa	US	Visa	US	Visa	US	Visa
All segments	53.7%	33.2%	35.6%	37.9%	38.4%	30.1%	25.3%	28.2%	28.2%	20.0%	26.2%	16.8%	18.5%	7.1%
Private high segments	63.9%	23.8%	56.0%	15.0%	56.5%	23.4%	17.5%	13.1%	31.2%	17.6%	26.4%	10.9%	12.9%	2.1%
Private low segments	52.0%	39.9%	50.1%	14.8%	52.0%	19.2%	27.1%	16.0%	–	–	33.0%	16.7%	13.4%	4.5%
Public high segments	59.2%	21.8%	51.7%	26.6%	25.7%	37.4%	35.9%	23.2%	19.9%	20.4%	35.8%	16.7%	17.4%	4.5%
Public low segments	47.3%	34.2%	40.6%	35.6%	42.8%	25.8%	28.9%	30.0%	36.2%	30.7%	25.9%	18.6%	23.6%	7.9%

	Computer Sci.		Math		Mech. Eng.		Elect. Eng.		Civil Eng.		Unweighted average		
	US	Visa	US	Visa	US	Visa	US	Visa	US	Visa	US	Visa	All
All segments	12.2%	28.8%	20.1%	12.2%	16.8%	15.9%	12.4%	17.4%	5.6%	10.8%	24.4%	21.5%	23.0%
Private high segments	15.6%	27.9%	11.3%	9.3%	18.5%	14.1%	7.4%	17.7%	4.0%	6.9%	26.8%	15.2%	21.0%
Private low segments	–	–	26.7%	12.2%	–	–	8.5%	12.2%	–	–	32.9%	16.9%	24.9%
Public high segments	14.1%	24.2%	24.2%	9.7%	27.8%	10.3%	17.3%	19.9%	4.2%	9.0%	27.8%	18.6%	23.2%
Public low segments	–	–	9.7%	16.2%	27.7%	18.6%	–	–	12.1%	16.0%	28.2%	22.0%	25.1%

Table 2.12
Ratios of High to Low Segment Percentile Times to Degree
(U.S. Citizens)

	Private Segments			Public Segments		
	10%	50%	90%	10%	50%	90%
Physics	1.04	0.97	0.89	1.02	0.99	0.95
Biology	1.04	1.11	1.05	1.04	1.07	1.09
Chemistry	1.02	0.91	0.77	0.98	0.95	0.90
Geosciences	1.01	1.00	0.86	1.00	0.96	0.85
Chemical Engeneering	-	-	-	1.03	0.97	0.86
Economics	1.00	0.99	0.94	0.97	0.92	0.86
Psychology	1.19	1.27	1.31	0.94	0.98	0.98
Computer Science	-	-	-	-	-	-
Math/Stat	0.90	0.93	0.93	0.96	0.97	0.97
Mechanical Engineering	-	-	-	0.92	0.90	0.80
Electrical Engineering	0.92	0.95	0.89	-	-	-
Civil Engineering	-	-	-	1.13	1.01	0.84

Table 2.12 presents information on time-to-degree (TTD), by segment, for U.S. citizens. The computational difficulties noted earlier for visa-holders' TTD were somewhat more pronounced at the segment level, so we do not present those results. We summarized the TTD information by taking the ratio of the high-segment to the low-segment figure for the 10th, 50th, and 90th percentiles, by type of control.

The data show that most students tend to attain the doctorate faster in high-segment schools than in the low-segment ones. For example, the ratios for median TTD are less than one in 13 of the 18 cases (72%, about two sigma). The figures for the 90th percentile are even more skewed: high-segment TTD is less than low-segment TTD in 15 of the 18 cases (83%, almost 4 sigma). On the other hand, the 10th-percentile figures are fairly even (7 of 18 less than one, or about 39%). We conclude that students in the low segments tend to take longer to attain the degree and that the lag becomes more pronounced as time-to-degree increases.

IV. Conclusion

We have presented a stochastic model for predicting the asymptotic graduation probability, the expected time to the PhD. degree, and related quantities. The model was derived from assumptions about the time path of an individual's graduation and dropout propensity, and the distribution of these propensities over the population of entering students. By modeling population heterogeneity explicitly, the model avoids the data censoring problems that have been cited in the recent literature. Parameter estimates are obtained by a minimum chi-square procedure, which is consistent and asymptotically efficient. Parameters can be estimated for U. S. citizens and non-citizens, for institutional segments, and for time intervals of fairly short duration. While requiring substantial computation effort, the parameter estimation procedure appears to be robust as assessed by the interpretability of results for various cuts at the data and by the standard errors of the coefficients.

We offer several suggestions for follow-up work. First, the model as presently constituted estimates the matriculants' time trends separately for U.S. citizens and visa holders, subject only to the constraint that the matriculants' fractions must sum to one in 1985. However, equation (2.10) probably can be modified so that the fractions sum to one in every year. (This requirement was added for purposes of simulation but not incorporated in the doctoral cohort estimation process.) Constraining all the matriculants fractions would produce a more precise and realistic model and also reduce the number of parameters. We would

expect that the new model would produce results which are very similar to the ones presented here, but that, perhaps, the occasional anomalies would disappear.

A second follow-up task would be to find a better minimizing process for the model's sum of squared errors. The combination of pattern search and Mathematica's *FindMinimum* routine worked well enough for present purposes but without much slack. Most estimation runs took at least a day, and a few took as long as a week. Faster minimization would improve our ability to do sensitivity analyses and to trouble-shoot difficulties. Alternatively, the model's objective function could be implemented in compiled C-code, or faster machines than the Sun workstations we used could be made available.

The combination of a revised model and faster parameter estimation might make it possible to run the model for individual segments rather than groups of segments. This would utilize the available data to greater advantage and provide more insight about inter-segment differences. If individual-segment estimation proves unfeasible, one surely could break the "Low-public" group, which for most fields now contains four segments, into two groups of two segments each. Additional analyses also could be done on shorter time periods, along the lines of the analysis reported for Physics in Table 2.5.

The fourth followup task involves processing the data for total time-to-degree. As noted earlier, we obtained data from the NRC for total time-to-degree as well as registered time-to-degree, but we have not had time to process the total time-to-degree data. While we believe the registered time-to-degree data are more relevant (certainly for the purposes of our simulation), the total time-to-degree data may produce additional insights. We believe, however, that tasks one through three, above, should be accomplished before turning to the total time-to-degree data.

In conclusion, we suggest that the model, as revised, be used on a regular basis to monitor trends in PhD production in the United States and perhaps in other countries where the requisite data exist. The new data that become available every year are too voluminous for easy interpretation, and we believe that the doctoral attainment model reported here could improve the situation materially. Additional work on institutional segmentation would be needed, since our segments were designed for a purpose other than monitoring PhD production. Indeed, it might even prove feasible to run the model on data for individual institutions. How the model might be used for on-going monitoring purposes should be a subject for further study.

References

Beightler, Charles S., Don T. Phillips, and Douglas J. Wilde [1979], *Foundations of Optimization*. Englewood Cliffs, NJ: Prentice-Hall, Inc.

Bowen, William G., Graham Lord, and Julie Ann Sosa [1991]. "Measuring Time to the Doctorate: reinterpretation of the evidence," *Proceedings of the National Academy of Sciences* 88 (February 1991), pp. 713-717.

Bowen, William G. and Neil L. Rudenstine [1992], *In Pursuit of the PhD*. Princeton, NJ: Princeton University Press.

Lehmann, E. L. [1991], *Theory of Point Estimation*. Pacific Grove, CA: Wadsworth & Brooks/Cole Advanced Books and Software.

Massy, William F., David B. Montgomery, and Donald G. Morrison [1970], *Stochastic Models of Buying Behavior*. Cambridge, MA: The M.I.T. Press.

National Science Foundation [1993]. *Science and Engineering Doctorates: 1960-91*. NSF 93-301. Detailed Statistical Tables. Washington, D.C.

Rao, Calyampudi Radhakrishna [1973], *Linear Statistical Inference and Its Applications*. New York: John Wiley.

Schwefel, Hans-Paul [1977], *Numerical Optimization of Computer Models*. New York: John Wiley & Sons.

Tuckman, Howard, Susan Coyle, and Yupin Bae [1990]. *On Time to the Doctorate: A Study of the Increased Time to Complete Doctorates in Science and Engineering*. Washington, D.C.: National Academy Press.

Wolfram, Stephen [1991], *Mathematica*. Redwood City, CA: Addison-Wesley Publishing Company, Inc.

Notes

[1]Bowen and Rudenstine [1992].

[2]Custom tabulations provided by the National Research Council of data from the Survey of Earned Doctorates, 1967-1992.

[3]Computer Aided Science Policy Analysis and Research Database System (CASPAR), developed for the National Science Foundation by Quantum Research, Bethesda, MD.

[4]See Massy, Montgomery, and Morrison , for a discussion of how such models have been used in consumer behavior research, where purchase propensities are similarly unobservable.

[5]Bowen and Rudenstine [1992], p.106.

[6]*Ibid.*, p. 122.

[7]*Ibid.*, p. 116 and Appendix D. See also Bowen, Lord, and Sosa [1991].

[8]Rao [1973], p. 352. See also Lehmann [1991], pp. 447-448.

[9]Beightler, Philips, and Wilde [1979], p.236. See also Schwefel [1977], p. 43.

[10]Wolfram [1991], p. 794.

[11]The Figure erroneously labels "Propensity" as "Probability." This will be corrected prior to publication.

[12]Tuckman, Coyle, and Bae [1990], Table A1, Physics/Astronomy, p. 115.

[13]National Science Foundation, *Science and Engineering Doctorates : 1990-91*, NSF 93-301, Detailed Statistical Tables, (Washington, D.C.: 1993): Table 5, Physical sciences: physics/ astronomy, pp. 153-154.

[14]The eight universities are: Berkeley, Chicago, Columbia, Cornell, Harvard, Princeton, Stanford, and UNC [Bowen and Rudenstine 1992, p. 134].

[15]Bowen and Rudenstine [1992], p. 132.

[16]National Science Foundation, *Science and Engineering Indicators: 1993*, Appendix Table 3-14 "Employed doctoral scientist and engineers, by degrees, field, and type of employer," 1991.

[17]See Tuckman, Coyle, and Bae, p. 31 and pp. 56 et seq., for a discussion of how salary affects time-to-degree.

Table 2-A.1
Doctoral Cohort Coefficients and Standard Errors
PHYS, BIOL, CHEM, GEOS, CENG

	PHYS U.S.	PHYS Visa	BIOL U.S.	BIOL Visa	CHEM U.S.	CHEM Visa	GEOS U.S.	GEOS Visa	CENG U.S.	CENG Visa
Time factors										
begin-progress	2.019	1.406	0	0.006	1.774	1.667	2.081	1.306	1.657	1.939
	(0.064)	(0.075)	(0)	(0.592)	(0.019)	(0)	(0.04)	(0.085)	(0.038)	(0.098)
begin-sustain	18.	13.85	6.56	18.	9.35	17.34	17.19	11.88	12.69	14.
	(0)	(3.3)	(1.12)	(0)	(im)	(1.54)	(im)	(0.76)	(im)	(4.12)
Propensities										
graduate-shape	1.867	4.639	0.48	14.391	2.371	3.282	0.93	5.616	1.552	3.651
	(0.172)	(1.752)	(0.292)	(0.124)	(im)	(0.452)	(0.059)	(im)	(im)	(0.882)
graduate-scale	2.684	0.29	0.254	0.01	1.032	1.204	3.519	0.162	2.234	0.957
	(0.406)	(0.229)	(0.27)	(0)	(im)	(im)	(im)	(im)	(im)	(0.516)
dropout-shape	3.08	4.07	0.3	0.87	0.39	0.942	2.751	1.696	2.239	2.601
	(1.452)	(im)	(na)	(na)	(0.018)	(im)	(im)	(0.535)	(0.415)	(im)
dropout-scale	0.038	0.051	0.01	0.01	2.112	0.467	0.097	0.183	0.152	0.165
	(0.02)	(im)	(0)	(0)	(0.214)	(im)	(im)	(0.089)	(0.038)	(im)
Matriculants										
percent	0.535	0.465	0.7	0.3	0.678	0.322	0.783	0.217	0.562	0.438
	(0.009)	(na)	(0.016)	(na)	(0.01)	(na)	(0.012)	(na)	(0.011)	(na)
linear	39.91	37.71	-36.43	18.72	-51.87	79.22	-137.89	10.46	-41.92	8.01
	(0.1)	(0.12)	(1.05)	(1.05)	(5.32)	(4.71)	(8.46)	(5.19)	(6.12)	(5.44)
quadratic (x10)	3.848	-3.834	5.106	0.013	-5.538	1.102	-9.534	-0.203	-7.217	-0.294
	(0.546)	(0.504)	(0.285)	(0.277)	(1.382)	(0.934)	(0.996)	(0.624)	(1.081)	(0.825)
cubic (x1000)	0.014	-0.182	0.049	-0.018	-0.338	-0.047	-0.13	-0.006	-0.275	0.016
	(0.028)	(0.026)	(0.038)	(0.024)	(0.063)	(0.04)	(0.032)	(0.02)	(0.043)	(0.029)

Table 2-A.2
Doctoral Cohort Coefficients and Standard Errors
ECON, PSYC, CSCI, MATH

	ECON U.S.	ECON Visa	PSYC U.S.	PSYC Visa	CSCI U.S.	CSCI Visa	MATH U.S.	MATH Visa
Time factors								
begin-progress	1.263	1.411	1.367	0.342	1.972	1.971	1.5	1.308
	(0.06)	(0.061)	(0.122)	(im)	(0.084)	(0.117)	(0)	(0.091)
begin-sustain	18.	17.99	17.79	14.84	16.25	9.83	17.74	12.25
	(0)	(1.78)	(2.26)	(im)	(2.05)	(1.27)	(2.08)	(1.93)
Propensities								
graduate-shape	0.964	2.685	1.594	25.275	1.221	4.122	1.546	18.2
	(0.067)	(0.256)	(0.166)	(im)	(0.141)	(1.119)	(0.104)	(im)
graduate-scale	3.026	1.003	2.378	0.05	1.535	0.214	2.58	0.071
	(0.359)	(im)	(0.932)	(im)	(0.458)	(0.088)	(0.63)	(im)
dropout-shape	3.633	3.638	0.32	0.437	0.753	0.38	1.928	1.405
	(im)	(0.341)	(0.012)	(0.056)	(0.061)	(0.069)	(im)	(0.102)
dropout-scale	0.072	0.111	33.185	77.626	2.179	4.194	0.236	0.655
	(im)	(0.013)	(5.314)	(39.669)	(0.403)	(2.057)	(im)	(0.083)
Matriculants								
percent	0.462	0.538	0.924	0.076	0.68	0.32	0.533	0.467
	(0.008)	(na)	(0.007)	(na)	(0.002)	(na)	(0.007)	(na)
linear	-41.91	51.51	117.01	46.92	115.04	104.44	25.49	79.64
	(0.09)	(0.1)	(17.29)	(9.32)	(11.75)	(6.71)	(7.59)	(7.18)
quadratic (x10)	4.417	0.736	17.898	3.467	1.506	1.603	-1.323	3.802
	(0.653)	(0.621)	(4.275)	(2.77)	(1.301)	(0.263)	(1.742)	(1.598)
cubic (x1000)	0.203	0.005	0.377	0.011	0.033	-0.008	-0.447	0.117
	(0.024)	(0.031)	(0.207)	(0.169)	(0.036)	(0.002)	(0.087)	(0.064)

Table 2-A.3
Doctoral Cohort Coefficients and Standard Errors
MECH, ELEC, CIVL, INDU

	MECH U.S.	MECH Visa	ELEC U.S.	ELEC Visa	CIVL U.S.	CIVL Visa	INDU U.S.	INDU Visa
Time factors								
begin-progress	1.444 (0.052)	1.444 (0.073)	1.6 (0.178)	1.555 (0.318)	1.5 (0)	1.613 (0.039)	1.167 (0.064)	1.791 (0.085)
begin-sustain	9.34 (0.64)	18. (38.85)	18. (276.63)	14.42 (1.69)	11.64 (0.44)	16.4 (2.61)	11.64 (im)	10. (0)
Propensities								
graduate-shape	2.426 (0.368)	8.714 (1.881)	1.039 (0.692)	3.004 (9.484)	1.8 (0.072)	5.204 (0.829)	0.197 (im)	4.123 (0.315)
graduate-scale	0.275 (0.072)	0.425 (0.105)	2.827 (2.372)	0.589 (1.838)	0.5 (im)	0.643 (0.034)	1.619 (im)	0.712 (0.206)
dropout-shape	4.26 (0.46)	0.993 (0.059)	3.413 (2.699)	8.284 (19.907)	3.66 (im)	2.439 (im)	4.873 (im)	5.154 (1.916)
dropout-scale	0.087 (0.012)	1.039 (0.135)	0.136 (0.149)	0.041 (0.112)	0.2 (im)	0.286 (im)	0.089 (im)	0.077 (0.037)
Matriculants								
percent	0.515 (0.011)	0.485 (na)	0.627 (0.069)	0.373 (na)	0.573 (0.004)	0.427 (na)	0.679 (0.02)	0.321 (na)
linear	27.13 (0.14)	35.33 (0.1)	111.32 (1.34)	77.12 (0.87)	-19.58 (7.43)	4.67 (6.2)	23.51 (8.2)	24.11 (5.76)
quadratic (x10)	-5.554 (0.895)	-4.983 (0.738)	0.857 (8.757)	-2.597 (5.397)	4.259 (1.883)	-5.373 (1.311)	6.033 (1.119)	0.075 (0.627)
cubic (x1000)	-0.475 (0.317)	-0.195 (0.037)	-0.365 (0.46)	-0.131 (0.253)	0.08 (0.075)	-0.163 (0.053)	0.173 (0.037)	-0.01 (0.018)

Chapter 3
Doctorate and Pre-Doctorate Utilization In Academic Science and Engineering Departments

The market for doctorates in science and engineering has become an important topic for policy and research.[1] This paper describes a model for predicting doctoral supply and demand at the departmental level. Taking departmental workloads (non-doctorate degree production and sponsored research) as drivers, the model predicts departmental demand for doctoral students, faculty, and postdoctoral fellows. All three endogenous variables contribute to degree and sponsored research production; faculty also contribute to the production of doctorates.

The model is rooted in the micro-economic theory of non-profit enterprises,[2] wherein decision makers allocate resources by maximizing a utility function subject to production and financial constraints. Departments may attribute intrinsic utility to the endogenous variables and also value them instrumentally because of their contributions to production. We model and estimate both kinds of utility effects as well as the financial effect. Using these estimates, we predict the endogenous variables by means of mathematical programming. Estimated income, price, and transformation elasticities can then be obtained by varying the corresponding parameters and drivers.

The chapter consists of three sections. The first section describes the model's mathematical structure and develops an appropriate parameter estimation procedure. The second section analyzes the Physics field in considerable detail: first in terms of the meaning of the coefficients, then in terms of the estimator's stability, and finally in terms of the sensitivity of the departmental simulator to changes in the driver variables' prices and quantities. The third section extends the Physics results to all twelve science and engineering fields included in our dataset, which produces the parameters used in the doctorate supply-demand simulation reported in Chapter 1.

I. The Model

Data and Definitions

Our database consist of records for the science and engineering departments of each institution included in the National Science Foundation's CASPAR files.[3] While much government data are available as time series, the key figures needed for this study are limited to a single cross-sectional sample for the year 1980. For each department, we define:

Endogenous variables

Fac: faculty (FTE)[4]

Doc: doctoral enrollments (headcount)

PostDoc: post-doctoral fellows (FTE)

Exogenous variables

BachAll: undergraduate enrollment for the institution as a whole (FTE)

Bach: baccalaureate degrees granted in the major (number)

Masters: masters degrees granted in the major (number)

R&D: total sponsored research generated by the department ($000)

Departmental descriptors

S-index: segment index (a continuous variable, defined below, where the positive direction indicates "elite" institutions); in equations, *S-index* is abbreviated to *S*.

Toc: dummy variable for type of institutional control (0 for public institutions; 1 for private institutions); in equations, *Toc* is abbreviated to *T*.

For compactness, we sometimes denote the endogenous variables by the vector **y**, the exogenous variables by **x**, and the segment descriptors by **z**.

We obtained the segment index from the analysis used to divide doctorate-granting departments into homogeneous groups for purposes of simulation (see Chapter 1 and Chapter 5). For Physics, this produced four private-sector segments and six public-sector ones. The value of *S-index* for each segment was set to equal the average factor score for the segment, with the more "elite" institutions having the larger scores. Under this scheme, *S-index*=0 represents the hypothetical "average institution." The *S-index*

values for Physics and the other eleven fields in our dataset are reported in Chapter 4.

Three additional segments represent the non-doctoral-granting institutions: private liberal arts colleges, private comprehensive universities, and public colleges and comprehensive universities. The original *S-index* and *Toc* are irrelevant for these segments (as are *Doc* and *PostDoc*), but we added a new segment variable based on the institution's Carnegie rating: *S-index*=1 for LAC1 and C1, and 0 for LAC2 and C2. In contrast to the doctoral sector, where the data for all the segments were pooled, the model is estimated separately for each non-doctoral segment.

Structural Equations

Our presentation begins with the financial constraint and then moves on to the utility and production functions. Parameter estimation procedures are developed in the following section, and then statistical results will be reported.

Finance. The financial constraint prevents the total cost of *Doc*, *Fac*, and *PostDoc* from exceeding the department's resources as determined by the exogenous variables. The equation involves three types of coefficients:

- **c**, the department's *marginal costs* for *Doc*, *Fac*, and *PostDoc*, taken as negative to denote cost.
- **r**, the department's *marginal revenues* for *BachAll*, *Bach*, *Masters*, *and R&D*, as these revenues are applied to defray the costs of *Doc*, *Fac*, and *PostDoc*,
- r_0, *fixed revenue (fixed cost):* costs not associated with *Doc*, *Fac*, and *PostDoc;* i.e., the net of the department's fixed revenue and fixed cost.

Using these definitions, we write the financial constraint as:

$$\mathbf{c}'\mathbf{y} + r_0 + \mathbf{r}'\mathbf{x} \geq \mathbf{0} \tag{3.1}$$

Doctoral tuition and financial aid are excluded from both sides; these quantities would offset each other because nearly all doctoral students receive financial support.

The revenue assumptions are most easily justified when an explicit budgeting formula allocates unrestricted funds to departments in proportion to enrollment and sponsored research income. We need not assume

formulaic budgeting, however, since any resource allocation system will respond eventually to exogenous revenue shifts.

The so-called revenue theory of budgeting holds that universities raise all the money they can and spend all the money they raise,[5] and we believe the same applies to academic departments. This means the financial constraint binds on average, so (3.1) can be written as an equality. We can estimate each department's **c** from independent data as described below; hence we collapse **c'y** to a single number and move it to the left-hand side—which produces a regression equation. We also postulate that r_0 and **r** interact linearly with the segment descriptors, which leads us to define interaction functions as illustrated here for revenue in the k^{th} segment:

$$r_k = r_{k\bullet} + r_{kS}S + r_{kT}T \tag{3.2}$$

Henceforth, all references to r_0 and **r** should be understood to include the possibility of segment interactions. Equation (3.4), presented later, shows the resulting financial regression.

Estimation of marginal cost begins with Association of University Personnel Administrators' data on overall average faculty compensation, and average assistant professor compensation, for all institutions and fields. (The compensation figures include fringe benefits.) The next step adjusts the overall average by the CASPAR figure for average faculty compensation for the institution in question. The final step, which produces a field and institution-specific index, multiplies the institution's average by the ratio of faculty salaries in the field being analyzed (as published in the *Chronicle of Higher Education*) to the average for all fields.[6] Informal evidence suggests that doctoral TAs and RAs receive about one-third the salary of an assistant professor, and that post-doctoral fellows receive about two-thirds of an assistant professor's pay, so we used those ratios. Fortunately, tests showed the model to be insensitive to the exact figure.

Production and utility. We assume that departments value all three endogenous variables. Doctoral and postdoctoral students are valued as outputs of the educational process. Faculty are valued not only as inputs but also, as in the case of monks in the medieval monastery, "for the good of the scholarly order"—that is, for their own sake, as colleagues. The main value-effect, the linear term in the utility function, is represented by **λ'y** where the elements of **λ** are all positive. As for the financial coefficients, **λ** depends on the segment characteristics according to the scheme described in (3.2).

Departments also recognize that *Doc*, *Fac*, and *PostDoc* represent inputs to the educational and research processes. Resources must be spent on them in order to produce *BachAll*, *Bach*, *Masters*, and *R&D*, and to obtain the revenues associated with these outputs. The simplest formulation holds that the three inputs must be present in sufficient quantities to produce the exogenous output quantities at historic quality levels. Following this line of reasoning, we postulate the following:

$Doc \geq L_D[BachAll, Bach, R\&D]$

A department's doctoral degrees depend on institution-wide and in-major undergraduate degrees because of the need for TAs, and on sponsored research because of the need for RAs.

$Fac \geq L_F[BachAll, Bach, Masters, Doc, R\&D]$

Faculty size depends on general undergraduate degrees, in-major degrees, masters degrees, and doctoral degrees because of instructional needs; and on sponsored research because of the need for research assistants.

$PostDoc \leq L_P[Fac, R\&D]$

The number of post-doctoral students is limited by the number of faculty supervisors and sponsored research funding.

We assume that the coefficients in the constraints depend on *S-index* and *Toc*, as illustrated in (3.2).

According to the above formulation, the department's decisions would maximize $\lambda'y$ subject to the production and financial constraints. Suppose, however, a department views the constraints not as strict requirements, but rather as norms or rules of thumb. Violations are penalized in the utility function, because they threaten output quality or financial viability. Slack is penalized as well, but for a different reason: the penalty for slack represents diminished marginal utility. Suppose, for example, that a department considers the possibility of dramatically increasing faculty size while holding doctoral and post-doctoral enrollments constant at their norms. Penalizing utility for the resulting faculty-constraint slack increases the marginal rate of substitution (in utility terms) of Fac for *Doc* and *Fac* for *PostDoc*. If we assume that both penalties are quadratic, the new formulation satisfies the basic assumption required for optimization—namely, that the objective function should be convex.

It seemed likely, given the above logic, that the penalties for violating the production constraints would be greater than those associated with slack.

Therefore, we make provision for asymmetric penalties by writing the basic model in the form of a goal program.[7] Writing positive and negative deviations and their associated weights with the superscripts "+" and "–", the model becomes:

$$(3.3)\ u[\mathbf{y}] = \lambda'\mathbf{y} - \sum_{k=1}^{3} w_k^+ \left\{(\mathbf{y} - \mathbf{L}_k[\mathbf{y},\mathbf{x}])^+\right\}^2 - \sum_{k=1}^{3} w_k^- \left\{(\mathbf{y} - \mathbf{L}_k[\mathbf{y},\mathbf{x}])^-\right\}^2 - \left\{(\mathbf{c}'\mathbf{y} + r_0 + \mathbf{r}'\mathbf{x})^-\right\}^2$$

which is to be maximized with respect to **y** for $\mathbf{y} \geq \mathbf{0}$. The financial constraint remains an inequality, with only negative deviations entering the objective, since we assume no penalty for running a budget surplus. (The positive utility weights on **y** preclude a substantial surplus, however.) The financial-function weight has been pegged at one without loss of generality, which makes it the system's numeraire.

Estimation

We estimate the parameters of (3.3) from cross-sectional data. Estimation proceeds in two stages. First we estimate the financial coefficients by ordinary least squares; then, we estimate the production coefficients by a special procedure to be described below. We did not attempt to estimate the penalty asymmetries directly. Instead, we estimated the parameters of a symmetric approximation and calculated the asymmetry factor from the residuals.

We define the following extensions to the exogenous variables to handle interactions with the segment descriptors during the estimation process.

$$\mathbf{y}_{z,i} = \begin{bmatrix} \mathbf{y}_i \\ z_{1i}\mathbf{y}_i \\ z_{2i}\mathbf{y}_i \end{bmatrix}, \qquad \mathbf{x}_{z,i} = \begin{bmatrix} \mathbf{x}_i \\ z_{1i}\mathbf{x}_i \\ z_{2i}\mathbf{x}_i \end{bmatrix}$$

where $x_{z,i}$ and $y_{z,i}$ are column vectors of 9 and 12 elements, respectively, representing the i^{th} department in our sample.

The financial equation. The marginal cost coefficients for *Doc*, *Fac*, and *PostDoc* have already been calculated from exogenous financial, so we have figures for $\mathbf{c}'\mathbf{y}$. We form the following regression in the unknown r_0 and **r**:

$$(3.4) \qquad \mathbf{c}'\mathbf{y}_i = y_i^* = r_0 + \mathbf{r}'\begin{bmatrix} \mathbf{x}_{z,i} \\ \mathbf{z}_i \end{bmatrix} + u_i$$

where y_i^* is the dependent variable, $[\cdot]$ a 14-element column vector joining $x_{z,i}$ and z_i, and **r** the corresponding vector of revenue coefficients. The coefficients

(r) and regression constant (r_0) can be estimated by ordinary least squares. The residuals can be viewed as transitory surpluses and deficits—deviations from financial equilibrium that will be corrected by future decisions. We will designate the negative residuals by u_i^-, where $u_i^-=0$ if the i^{th} residual is positive.

Departmental decision rule. The symmetric departmental objective function can now be written as:

$$(3.5) \qquad \max_{\mathbf{y}_i} \; 2\lambda'\mathbf{y}_i - \left(\Gamma\mathbf{y}_{z,i} + \mathbf{B}\mathbf{x}_{z,i}\right)' \mathbf{W}\left(\Gamma\mathbf{y}_{z,i} + \mathbf{B}\mathbf{x}_{z,i}\right) - \left\{\left(\mathbf{c}'\mathbf{y}_i + r_0 + \mathbf{r}'\mathbf{x}_{z,i}\right)^-\right\}^2$$

where Γ and B are the production-function coefficients, **W** is a diagonal matrix of weights, and the last quantity equals u_i^-. The necessary conditions for maximizing (3.5) can be written as:

$$(3.6) \qquad \lambda_{k0} + \lambda_{kS}S_i + \lambda_{kT}T_i - w_k y_k - w_k \mathbf{M}_{k,i} f_k[\theta] - \mathbf{c}_k u_i^- = \varepsilon_{k,i}, \quad k = 1,2,3$$

$\mathbf{M}_{ki}$ is a vector of polynomials in $\mathbf{x}_i$, $\mathbf{y}_i$, and $\mathbf{z}_i$, and $f_k[\theta]$ is a vector of polynomials in the elements of Γ, B, and **W**. (The definitions of $\mathbf{M}_{ki}$ and $f_k[\theta]$ are given in Appendix Table A-3.) The right-hand side (ε_{ki}) is a stochastic variable representing error in the department's optimization. We assume that the expectation of ε_{ki} is zero.

Estimation procedure. Estimates of the financial-function coefficients are already in hand, so our task is to estimate the elements of λ, Γ, B, and **W**. The system is triangular, with the third equation (for *PostDoc*) standing alone, the second (for *Fac*) depending on the third, and the first (for *Doc*) depending on the other two. Because the system is triangular, it meets all the conditions for identifiability, and we can estimate the equations sequentially: (3.3) first, then (3.2), and finally (3.1).

Estimation for the k^{th} equation begins by regressing $\mathbf{y}_k$ on $\mathbf{x}_{z,i}$ and z_i to obtain the reduced-form coefficients. The reduced-form predictions are used everywhere except for the left-hand sides of the structural regressions (shown below), where actual values are used; this removes the structural errors from the right-hand-side *y*-variates, thus avoiding bias. The next step is to multiply the equation by $1/w_k$ (which we define as ϕ_k) and bring y_k to the left-hand side, which produces the regression:

$$(3.7) \qquad y_k = \phi_k\lambda_{k0} + \phi_k\lambda_{kS}S_i + \phi_k\lambda_{kT}T_i - \mathbf{M}_{k,i} f_k[\theta] - \phi_k \mathbf{c}_k u_i^- + \varepsilon_{k,i}, \quad k = 1,2,3$$

This step is required for y_k to serve as the dependent variable: that is, for the sum of squares to be minimized in the y_k direction, consistent with the purpose of predicting y_k, rather than in direction of the financial-equation residuals. We then proceed as follows to estimate the parameters of (3.7) for the k^{th} equation. (Step iii does not apply to the non-doctoral segments, since *Fac* is the only endogenous variable.)

i. Subtract off the means of M, *S,-index Toc,* and $c_k u^-$, which removes λ_{k0} from the equation.

ii. Minimize the sums of squared errors of the three equations in (3.6) with respect to θ_k and ϕ_k.

iii. Where the equation depends on the prior equations' θ, we proceed iteratively to make the w-values from the successive equations consistent with one another:

   a. Set w_k =1 and estimate the equation; if ϕ_k equals the ϕ from the previous equation, proceed directly to step iv.

   b. Update w_k by multiplying the previous one by the ratio of the newly estimated ϕ_k to the ϕ estimated in the previous equation.

   c. Repeat step "b" until the estimated ϕ_k become stationary.

iv. Obtain λ_{k0} from (3.7) by inserting the estimated value of θ_k and adding back the means of all the variables.

v. Calculate the coefficients' standard errors by multiplying the inverse of the information matrix (the matrix of objective-function second-order partial derivatives, evaluated at the estimated parameter values) by twice the equation's variance of estimate.

vi. When all the equations have been estimated, divide λ and **w** by the ϕ-value as estimated from the last equation (equation 1), to obtain the final λ and **w**.

The above amounts to a two-stage least squares procedure, so the estimates have the usual desirable properties. We have not tried to prove convergence of the ϕ-iteration, but as a practical matter the procedure appears robust.

The $f_k[\theta]$-functions are non-linear, so the normal least-squares solution procedure cannot be used. Therefore, we adopted a Gaussian optimization procedure.[8] The method works well when the objective is the square of an underlying non-linear function, in our case a polynomial in the unknown parameters. The iteration usually converges in only a few iterations.

Examination of the residuals indicated that, as expected, their distributions are skewed to the right for all three production equations and also for the financial equation. This indicates that the penalties for violating constraints are greater than the ones for slack, but the question of quantifying the production-asymmetry remains. We proceed by partitioning the residuals of (3.7) into positive and negative components and writing the weights for the partitions as $m_k^+ w_k$ and $(1-m_k^+) w_k$. The necessary conditions for a maximum require that the expected penalties for positive and negative penalties be equal at the department's optimum decision point:

$$\text{(3.8)} \qquad \mathrm{E}\left[\left\{m_k^+ w_k \mathbf{M}_{k,i} f_k[\theta]\right\}^2\right] - \mathrm{E}\left[\left\{(1-m_k^+) w_k \mathbf{M}_{k,i} f_k[\theta]\right\}^2\right] = 0$$

It is a simple matter to numerically minimize the sum of squares corresponding to (3.8) with respect to m_k^+.

Simulation

Departmental choice behavior can be simulated by applying (3.3) to the exogenous variables. The simulation uses aggregate values for *BachAll*, *Bach*, *Masters*, and *R&D*, treating the segment as if it were a single institution, and produces aggregate values for *Doc*, *Fac*, and *PostDoc*.

Calibration. Since the optimization is not a linear operation, applying (3.3) to an aggregate **x** does not necessarily reproduce the segment's aggregate **y**. Hence we added a segment-specific calibration constant to each constraint, so that each holds exactly at the observed aggregate **x**. The calibrations assume that each aggregate "department" operates at its production norms and on its budget constraint, and that it will set *Doc*, *Fac*, and *PostDoc* to equal the observed **y** when presented with the segment's observed **x**. Once calibrated, the model predicts the "department's" responses to variations of **x** from its observed value.

Limit constraints. Additional constraints will be needed when we use the departmental decision simulator in our larger model. Suppose, for example, that the simulator calls for fewer faculty than currently reside on the department's roster and that the model's attrition expectations do not produce the desired faculty numbers even if hiring is brought to zero. Simply setting faculty to the achievable number is not appropriate, since the doctoral and postdoctoral population would be no longer consistent with faculty size. Hence we include limiting constraints in the optimization itself. In the above example, the lower limit on faculty would equal the expected population with

no hiring. Absent constraining circumstances, the lower bounds are set to zero and the upper ones to plus infinity.

Piecewise-linear approximation. The optimization is best accomplished through quadratic programming. Lacking a suitable quadratic programming routine callable from Mathematica, we used a piecewise-linear function to approximate the quadratic objective in a linear programming formulation.[9] Each of the seven terms in (3.3) was approximated by h+1 linear segments. The first h pieces span distances equal to the square root of sum of squares of D^+ or D^-, according to the term being calculated; the last piece in each set is unbounded. Experimentation indicated that h=10 is sufficient to capture the quadratic's curvature for the range of deviations encountered in the simulation.

Binding Financial Constraint. Estimation proceeded under the assumption that departments would usually spend all available funds: hence only the negative financial residuals were used in equations (3.5) and (3.6). Tests with the simulation, however, showed that our estimates of the weighting factors (w_k) are not precise enough to allow the equations to be used in their original form. Specifically, the weights appear to be too large. The production constraints overpower both the utility coefficients and financial constraints. Income improvements fail to call forth additional faculty, doctoral students, and postdocs; income reductions fail to limit departmental decisions, which leads to uncontrolled deficits.

To solve this problem, we modified the simulation algorithm to require the financial constraint to bind at all time. That is, we made the financial constraint two-sided and gave it essentially an infinite weight. The utility coefficients and production-constraint weights continue to function in terms of relative importance, but their role in determining overall resource use has been preempted by the always-binding financial constraint.

II. Results for Physics

This section explores the estimator's properties and demonstrates the decision simulator by using data for a single field: Physics. Results for all twelve science and engineering fields included in our dataset are presented in Section 3.

Both the financial-function and production-function estimators performed well. No problems were observed with production-function iteration convergence or intermediate results. The signs of nearly all the coefficients

are consistent with our theory, most of the coefficients are statistically significant, and the R-squares are generally quite high.

Financial Equations

Financial Equations: doctoral segments Table 3.1 reports three versions of the financial equation for the doctoral segments. The first column shows the base case, the one we used in the simulation: we will describe these results shortly. *Test A* adds Physics masters degrees to the equation. The *Masters* coefficient is very large and highly significant statistically. The figure is so large, $63,000 per masters degree, that we did not find it credible. Adding *Masters* also exerts a powerful effect on the *BachMajor* coefficients. The main effect is cut in half, and the sign of the interaction with type of control (*toc*) is reversed. The equation's degree of fit remains constant, however.

We believe that most Physics masters degrees are granted as milestones on the way to the doctorate or as consolation prizes, which implies a definitional relation between *Masters* and the number of doctoral students. The latter, one will recall, enters into the dependent variable for the financial equation. According to this line of reasoning, the effects of *Masters* are spuriously large, and the variable should be excluded from the equation.

Table 3. 1
Financial Regressions: Doctoral Segments

	Base run	Test A	Test B		Base run	Test A	Test B
Fixed revenue	-194.1	-30.6	-149.8	*R&D*	0.227	0.189	0.263
	(108.5)	(94.1)	(87.7)		(0.028)	(0.024)	(0.029)
BachAll	0.236	0.194	0.204	*R&D*S-index*	–0.253	–0.212	–0.225
	(0.041)	(0.035)	(0.039)		(0.058)	(0.049)	(0.062)
*BachAll*Toc*	–0.147	–0.122	–0.018	*R&D*Toc*	0.052	0.104	0.025
	(0.103)	(0.087)	(0.079)		(0.042)	(0.036)	(0.045)
BachMajor	11.592	6.259	20.588	*S-index*	1763.2	272.7	–
	(5.638)	(4.825)	(5.783)		(335.9)	(333.1)	
*BachMajor*Toc*	9.276	–3.894	14.689	*Toc*	216.5	254.0	–
	(11.50)	(9.882)	(12.24)		(172.6)	(146.5)	
Masters	–	63.04	–				
		(7.29)		R-squared	83.1%	83.1%	72.3%

Test B deletes the segment variables, *S-index* and *toc*, from the base-case model. R-squared drops by almost 11 points, but the only other material effect occurs for *BachMajor*. Both the main effect and the interaction with *toc* increase by about 50 percent; however, the relation between them is virtually unchanged. Adjusting fixed revenue according to the segment descriptors removes some of the effect that otherwise would be attributed to in-major degrees, a result we consider credible in view of the size of the coefficients and the strong statistical significant of *S-index* in the base model.

Turning now to the base case, in the first column of Table 3.1, we see that the main effects for the three included *x*-variates (*BachAll, Bach,* and *R&D*) are positive, and all are statistically significant. Next come the interactions with type of control. *BachAll*Toc* is negative, but since it is less than *BachAll* the combined effect when *Toc*=1 is still positive. None of the *Toc* interactions are significant, but we included them because we seek the best possible point estimates for purposes of simulation. *R&D*S-index* is negative, larger in absolute value that its main effect, and highly significant. The largest *S-index* value (0.8) occurs when *Toc*=1, however, so the combined effect of the three variables remains positive. The coefficient for the public segment with the largest *S-index* value (0.46) is positive as well. The main-effect coefficient for *S-index* is highly significant while that for *Toc* is not, but both exert a material effect on fixed revenue.

The coefficients present a fresh view of how funding for physics academic salaries depends upon output levels. For example, every additional general bachelors degree adds $235 to the average physics budget in public institutions but only $89 to private institutions. Apparently the public sector's greater reliance on formula funding percolates all the way to the departmental level. Both types of institutions respond strongly to variations in the number of physics baccalaureates: the budget increments are $11,590 in the public sector and an even more generous $20,870 in the private sector. (The figures refer to degrees attained, not to enrollments; the latter would produce considerably smaller marginal revenue estimates.)

The average private department has positive fixed revenue, since the positive *Toc* coefficient is larger than the negative intercept term. The more elite the institution, the larger the fixed revenue. Departments in the lowest *S-index* category have negative fixed revenue—that is, they are burdened with fixed costs that must be covered from their incremental revenues. Positive fixed revenue occurs most often in institutions with substantial endowment,[10] which is likeliest in the most elite private segment.

In the area of R&D, only 22.7% of the incremental dollar covers departmental academic salaries in public departments versus 27.9% in their private counterparts. These figures do not seem unduly low: in addition to the academic salaries defined in **c** (and hence included in the above percentages), R&D funding must cover other research expenses like technicians, travel, and equipment, and also university overhead. We do not know why the *Toc* coefficient is positive—a negative coefficient would have been consistent with the private sector's higher overhead rates—but it is not close to being statistically significant. Within each sector, departments in the more elite institutions receive substantially less funding than those in less elite institutions: this is consistent with the latter's proclivity for rebating overhead back to the department and principal investigator.

Our results can also be described by the financial tradeoffs between pairs of variables:

Type of control:	Private	Public
Bach:BachAll (%)	0.4%	2.0%
Bach:BachAll (n:n)	237	49
R&D:BachAll ($:n)	$321	$966
R&D:Bach($:n)	$74k	$51k

For public institutions, the model indicates that physics majors produce more departmental marginal revenue than overall baccalaureate production does if the former represents 2% or more of the total (*BachAll/Bach*=0.02). The breakeven figure is only 0.4% for private institutions, indicating greater sensitivity to majors in the private sector. The relation is illustrated further in the table's next line, which shows that private institutions require 237 total degrees to produce the departmental revenue associated with one physics major, as compared to only 49 degrees in the public sector. Physics departments in private institutions must get $321 in extra R&D support to equal the amount obtained from one general baccalaureate degree— a figure that triples in the public sector. On the other hand, the more lucrative funding for majors in private departments reverses the terms of trade when R&D is compared to in-major degrees.

Financial equation: non-doctoral segments. Table 3.2 presents the financial-equation coefficients for the non-doctoral segments: since the on-doctoral equations are relatively uncomplicated, only the base runs are presented. Unlike the doctoral segments, which are pooled for purposes of estimation, the three non-doctoral segments are estimated separately. The

Table 3.2
Financial Regressions: Non-Doctoral Segments

	Segment 11: private liberal arts	Segment 12: private comprehensive	Segment 13: public lib. arts & comprehensive
Fixed revenue (cost)	6.0 (3.4)	–0.3 (6.4)	–7.2 (12.5)
BachAll	0.145 (0.172)	0.136 (0.017)	0.170 (0.010)
BachMajor	3.253 (0.869)	9.187 (1.680)	4.198 (1.894)
Masters	104.98 (17.290)	28.786 (8.342)	
R&D	0.428 (0.036)	0.289 (0.011)	0.068 (0.056)
S-index	40.3 (4.7)	12.7 (8.2)	
R-squared	61.1%	85.7%	73.1%

model is somewhat different as well, due to the different segment designators, response sensitivities, and collinearity patterns. Masters degrees were included because there is no possibility of confounding with (non-existent) doctoral enrollments. The degree of fit exceeds 60% in all three segments.

Private liberal arts college departments garner less revenue per degree from in-major baccalaureate enrollments, and more from masters degrees, than do those in private comprehensive institutions. Revenue per degree from aggregate enrollment is about equal for the two private segments. The public institutions' undergraduate revenue-per-degree figures are similar to the privates', but the result for masters degrees was small and statistically insignificant. As might be expected, R&D is most important in the public sector, moderately important for the private comprehensives, and essentially zero for the private liberal arts colleges.

S-index is positive for both private segments but essentially zero for public institutions. It is largest in the liberal arts colleges, which indicates that the Carnegie-I colleges (where *S-index* equals one) tend to maintain physics department budgets independently of enrollment fluctuations to a greater extent than their less elite (and less affluent) counterparts. The negative fixed-revenue and zero *S-index* coefficient in the public sector imply that departments must garner enrollments to balance their budgets. The same is

true for the non-elite private liberal arts colleges, for which the value of *S-index* is zero.

Production equations

Production equations: doctoral segments. Tables 3.3 through 3.5 present the production-estimation results for the doctoral segments— again for the base run used in the simulation and two alternatives. Table 3.3 gives the results for the Doctoral equation, Table 3.4 for the Faculty equation, and Table 3.5 for the Postdoctoral equation. The figures for *BachAll* and *Weight* have been multiplied by 1000 and those for *Bach* and *Masters* by 10 to improve interpretability. The estimator performed well; no problems were observed with iteration convergence or intermediate results. We will describe the base run presently, but first, as in the case of the financial equation, we will discuss the two test runs.

Test A follows up on our concern about including *Masters* in the financial equation and also examines the effect of removing *Faculty* from the postdoctoral equation. (Additional tests deleted the variable sets one at a time; the results did not differ materially from those reported here.) We discussed the *Masters* problem in connection with the Financial equation. The sensitivity of *Faculty* was tested because it does not enter the Postdoctoral equation for most of the other fields.

We were particularly interested in the effect of removing *Masters* on the *Doctoral* coefficient in the faculty equation, even though it was not statistically significant. The Financial equation proved to be unstable when Masters was included, and one might have expected the same for the Faculty equation due to the correlation between faculty and doctoral-student numbers. The 2-stage least-squares procedure, however, has taken care of the problem. Neither the doctoral coefficients nor their standard errors are materially affected by the change. This result gains importance because of the interesting interpretations for the substitutability of doctoral students for faculty in the elite segments, which will be discussed below.

Removing *Faculty* from the Postdoctoral equation increases both the utility and the R&D coefficients. The main utility effect rises dramatically and its standard errors drops by half. Hence it appears that, for Physics, taking account of faculty reduces the apparent valuation of Postdocs. In other words, with Faculty absent from the equation, some of the value associated with faculty spills over to Postdocs. This effect may also be operating in the two other fields where faculty entered the Postdoctoral equation, Psychology and

Computer Science, since the ratio of the *PD* to *Fac* utility coefficients are rather small for those fields as well. The effect may operate in reverse in the other 9 fields, where *Faculty* did not enter the Postdoctoral equation because of insignificance or, in a few cases, collinearity problems. It does not seem likely that an insignificant *Fac*[*PD*] coefficient would affect the utility coefficient materially, however. The R&D coefficient also rise in absolute value, but the effect is not nearly as pronounced as the one for utility.

Table 3.3
Doctoral Production Coefficients: Doctoral Segments

	Base run	Test A	Test B		Base run	Test A	Test B
Utility	1.766	1.749	3.798	*Bach*	6.273	6.257	7.273
	(0.235)	(0.235)	(0.561)	(0)	(1.521)	(1.529)	(1.871)
*Utility*S-index*	15.974	15.771	–	*Masters*	–	–	–
	(2.620)	(2.638)		(0)			
Doc	–	–	–	*Masters*Toc*	–	–	–
*Doc*S-index*	–	–	–	*R&D*	11.63	11.60	11.30
				(000)	(0.83)	(0.80)	(1.00)
Fac	–	–	–	*R&D*S-index*	–9.32	–9.40	–7.10
					(1.20)	(1.20)	(1.50)
BachAll	9.098	9.100	7.300	Weight (000)	0.0724	0.0970	0.1627
(000)	(1.036)	(1.000)	(1.200)		(0.0122)	(0.0145)	(0.0070)
*BachAll*S-index*	31.89	32.10	47.90	R-squared	91.7%	91.6%	87.1%
(000)	(4.32)	(4.30)	(3.9)	df	193	193	194

Test B deletes *utility*S-index* from all three equations. The resulting utility main effects change materially, and the Postdoctoral coefficient goes negative. The other coefficients do not change much, but the R-squares drop by about 5 percentage points. We concluded from the test that including *utility*S-index* is worthwhile because it improves the utility estimate and enhances fit without affecting the rest of the structure.

We turn now to the base run, which provides some interesting insights into the world of academic Physics. Looking first at the main-effect utility coefficients (*utility*), we see that the value placed on an extra faculty member is much greater than that for doctoral students and postdocs, and that the *Fac* and *Doc* coefficients are highly significant. These coefficients refer to the average segment, for which *S-index*=0. (*Toc* was dropped from all three equations because of collinearity problems.)

Table 3.4
Faculty Production Coefficients: Doctoral Segments

	Base run	Test A	Test B		Base run	Test A	Test B
Utility	12.47	12.27	23.87	*Bach*	1.876	1.759	1.867
	(1.78)	(1.48)	(3.5)	(0)	(0.650)	(0.600)	(0.697)
*Utility*S-index*	51.97	54.38	–	*Masters*	0.559	–	2.012
	(2.62)	(19.85)		(0)	(2.106)		(1.872)
Doc	0.184	0.202	0.179	*Masters*Toc*	0.764	–	1.233
	(0.053)	(0.027)	(0.051)		(1.426)		(1.479)
*Doc*S-index*	–0.449	–0.386	–0.392	*R&D*	2.013	1.700	2.100
	(0.049)	(0.046)	(0.050)	(000)	(0.386)	(0.300)	(0.400)
Fac	–	–	–	*R&D*S-index*	–	–	–
BachAll	2.847	2.500	2.700	Weight (000)	1.730	1.667	2.564
(000)	(0.641)	(0.500)	(0.700)		(0.206)	(0.300)	(0.510)
*BachAll*S-index*	–	–	–	R-squared	77.6%	77.5%	72.8
(000)				df	191	193	192

Table 3.5
Postdoctoral Production Coefficients: Doctoral Segments

	Base run	Test A	Test B		Base run	Test A	Test B
Utility	0.650	4.112	–2.467	*Bach*	–	–	–
	(0.974)	(0.469)	(2.274)	(0)			
*Utility*S-index*	37.218	42.736	–	*Masters*	–	–	–
	(5.819)	(5.375)		(0)			
Doc	–	–	–	*Masters*Toc*	–	–	–
*Doc*S-index*	–	–	–	*R&D*	2.31	3.80	1.80
				(000)	(0.45)	(0.30)	(0.50)
Fac	0.303	–	0.450	*R&D*S-index*	–1.09	–2.80	0.20
	(0.067)		(0.074)		(0.56)	(0.40)	(0.60)
BachAll	–	–	–	Weight (000)	0.735	0.735	1.545
(000)					(0.098)	(0.097)	(0.042)
*BachAll*S-index*	–	–		R-squared	78.6%	76.3	71.2
(000)				df	195	196	197

The value placed on the three endogenous variables increases as one moves to the more elite segments, with the increase being largest for faculty and smallest for doctoral students. For the most elite segment (*S-index*=0.8), faculty are valued at 54 compared to postdocs at 30.5 and doctoral students at 14.6. For the least elite segment (*S-index*=–0.1), the figures are 7.3 for faculty, 0.2 for doctoral students, and –3.6 for postdocs. Since departmental decisions depend on the ratios rather than the raw values of the utility coefficients, the ratios follow:

	U[Doc]/U[[Fac]	U[PD]/U[[Fac]	U[PD]/U[[Doc]
Average segment	0.14	0.05	0.37
Most elite segment	1.17	2.57	12.12
Least elite segment	0.01	0	0

The negative excursion of post-doctoral utility in the least elite segment probably stems from the small numbers of postdocs relative to faculty and doctoral students in those institutions. For purposes of simulation, we simply clipped the negative excursion at zero—making the lowest segment indifferent to the use of postdocs as shown in the table. We do feel confident, however, in concluding that the more elite segments value postdocs more strongly relative to faculty and doctoral students than does the average segment. The more elite segments also value doctoral students more highly relative to faculty than the average segment does.

In addition to their intrinsic priority, the number of doctoral students desired by departments depends strongly on the departmental workload. A thousand more baccalaureate degrees calls forth almost 10 more doctoral students in the average segment, for instance ($BachAll[Doc]=9.1\cdot10^{-3}$). The effect increases to nearly 35 students in the most elite segment and declines to just under 6 students in the least elite segment. The observed interaction with *S-index* is highly significant statistically, which corroborates the conventional wisdom that the more elite schools use doctoral students more intensively for teaching general undergraduate physics than do their less elite counterparts.

The main effect of in-major baccalaureates on doctoral enrollment is somewhat less powerful than that of general baccalaureates : ten additional degrees generate a demand for 6.3 more doctorates ($Bach[Doc]=6.3\cdot10^{-1}$). The difference between the *Bach* and *BachAll* main-effect coefficients appears statistically significant, which again comports with the conventional wisdom that teaching assistants are used more often for elementary courses than for more advanced courses in the major. We deleted the *S-index*Bach*

interaction from the equation because the coefficient, though positive, was quite small and insignificant. The *Masters* variable was deleted from the doctoral equation—once again because of collinearity.

R&D also exerts a material effect on the demand for doctorates. The main effect is about 11.6 additional students for each $1 million of departmental research funding ($R\&D[Doc]=11.6\cdot10^{-3}$ with *R&D* measured in thousands). The figure is slightly larger (12.6 students) in the least elite departments, and it drops to 4.2 students in the most elite segment. This is consistent with the financial effects described earlier.

The demand for faculty depends on all four exogenous variables, but the effects are not as strong as those in the doctoral equation. Average faculty numbers increase by about 2.9 for an extra thousand general bachelors degrees, 0.6 for ten extra physics baccalaureates, 0.8 for ten extra physics masters degrees, and by about 2 for an extra million dollars in research funding. (*Masters* did not generate collinearity in this equation: adding and removing it did not materially affect the other coefficients.) The interactions with *S-index* generated considerable collinearity in this equation, so they were excluded. The *Toc* interaction with *Masters* appeared credible, and the *Toc* did not degrade the other estimates, so it was included. Since none of the *Masters* effects turned out be important in the simulation, however, this decision was of little consequence.

The most interesting driver of faculty size turned out to be the effect of doctoral student numbers. Both the main effect and the interaction with *S-index* are highly significant. The main effect indicates that an additional ten doctoral students generates a demand for 1.8 additional faculty in the average department ($Doc[Fac]=0.184$). The effect climbs to 2.3 in the least elite segment, but for departments in the most elite segment, faculty demand *drops* by about 0.4 when ten more doctoral students are added. It appears that adding doctoral students produces a net reduction in faculty workload in the elite private departments, whereas doctorates increase faculty workload elsewhere. One might say that doctorates are "producer goods" in the most elite segment (they produce more than they consume), and "consumer goods" in other segments (teaching them consumes more resources than are released through their employment as teaching and research assistants). This result proved to be robust in permutations of the Physics equation, and as noted later, we replicated the result in all the other fields.

Postdoctoral demand depends positively on sponsored research, but the coefficient is smaller than that for doctoral students ($R\&D[P]=2.3\cdot10^{-3}$). The

effect is smaller yet for the elite schools, where 1.4 post-docs are added per million dollars compared to 2.3 post-docs in the average segment and 2.4 post-docs for the least elite segment. We tested the effects of the other x-variates on postdoctoral demand but, not surprisingly, all were small and none were statistically significant.

Production equations: non-doctoral segments. Parameter estimates for faculty, the only equation that applies to the non-doctoral segments, are shown in Table 3.6. We varied the equation by adding the non-doctoral segment descriptor (*S-index*), but it did not produce worthwhile or statistically significant effects. As for the doctoral segments, the equations are well behaved and explain more than 75% of the variance in faculty size.

Table 3.6
Production Coefficients: Non-Doctoral Segments

	Seg. 11 pvt. LAC	Seg. 12 pvt. Comp.	Seg. 13 public
Utility	0.313	0.056	0.578
	(0.100)	(0.136)	(0.207)
BachAll	8.354	7. 639	6.596
(000)	(0.417)	(0.343)	(0.238)
Bach	2.073	3.494	1.077
(0)	(0.212)	(0.389)	(0.480)
Masters	7.585	12.601	–
(0)	(4.444)	(1.930)	
R&D	17.208	11.466	34.190
(000)	(1.093)	(0.251)	(1.441)
R-squared	78.8	95.2%	86.1%
df	351	293	298

The direct utility coefficients (*utility*) are positive, and two of the three are statistically significant. The public institutions appear to value faculty most strongly, followed by the private liberal arts colleges and comprehensives in that order. We should note, though, that these coefficients don't normally affect the simulation because—with only one decision variable— no tradeoffs come into play.

The effects of general and physics degrees are highly significant in all three non-doctoral segments. The private institutions seem to be more sensitive than their public counterparts, with the liberal arts colleges responding somewhat more to general degrees, and the comprehensives to degrees in the

major. General bachelors degrees exert a much stronger effect on faculty in the non-doctoral segments than in the doctoral-granting segments. Probably the latter's larger size dilutes the impact of general enrollment variations on individual departments. The in-major effects fluctuate across the non-doctoral segments, but the average is comparable to the average doctoral segment.

Masters degrees drive faculty size to a far greater extent in the private non-doctoral segments than in the doctoral sector. For private liberal arts colleges, an additional ten masters degrees calls forth 7.6 faculty, whereas for private comprehensive universities, the ratio is greater than 12.6 to 10. The *Masters* coefficient for the public comprehensives was negative but less than its standard error, so we deleted it.

The effect of R&D on faculty size also is much larger in the non-doctoral institutions than in the doctoral-granting ones. In private liberal arts colleges, an extra million dollars of departmental R&D "buys" 17 additional faculty; the figure falls to about 11 faculty in the private comprehensives, but it jumped to 34 faculty in the public non-doctoral sector. The larger non-doctoral effect comports with the proposition that doctoral-granting departments must spread research funds among doctoral students, postdoctoral fellows, and faculty, whereas the non-doctoral departments can concentrate them on faculty.

Correlations among the estimates

Table 3.7 reports the correlations among the parameter estimates for the three equations. The figures were computed from the estimated coefficients' variance-covariance matrix. (The coefficient's standard errors equal the square root of the diagonals of the information matrix.) As the tables are symmetric, we omitted the row headings, which are the same as the column headings.

Most of the correlations are quite low. Not surprisingly, the largest correlations occur between the main-effect and interaction terms: for example, the 0.91 between *R&D* and *R&D*S-index* in the Postdoctoral equation. We observed a certain amount of sensitivity to adding and deleting the interaction variables, but on the whole, the model is stable. Moreover, the standard errors of the coefficients tend to be rather small. The overall condition of the correlation matrices appears robust despite the occasional large correlations.

Table 3.7
Correlations Among the Parameter Estimates

Doctoral Segments: Doctoral Students

u[y]	1.00	0.01	-0.63	-0.22	0.00	0.29	0.03	0.22
u[y] si	0.01	1.00	0.27	-0.16	-0.10	-0.69	0.18	0.12
BachAll	-0.63	0.27	1.00	-0.27	-0.21	-0.32	-0.23	0.06
BachAll si	-0.22	-0.16	-0.27	1.00	-0.16	-0.14	0.06	0.04
Bach	0.00	-0.10	-0.21	-0.16	1.00	-0.05	0.83	0.20
R&D	0.29	-0.69	-0.32	-0.14	-0.05	1.00	-0.18	0.01
R&D si	0.03	0.18	-0.23	0.06	0.83	-0.18	1.00	0.20
Weight	0.22	0.12	0.06	0.04	0.20	0.01	0.20	1.00

Doctoral Segments: Faculty

u[y]	1.00	0.34	0.02	0.00	-0.40	-0.09	-0.09	-0.06	-0.42	0.29
u[y] si	0.34	1.00	-0.37	0.51	0.32	0.01	0.20	0.38	-0.30	0.30
Doc	0.02	-0.37	1.00	0.03	-0.72	-0.20	-0.84	-0.76	0.21	0.13
Doc si	0.00	0.51	0.03	1.00	-0.04	0.06	0.09	0.41	-0.03	0.18
BachAll	-0.40	0.32	-0.72	-0.04	1.00	0.00	0.45	0.55	0.14	0.04
Bach	-0.09	0.01	-0.20	0.06	0.00	1.00	0.06	0.02	-0.05	0.12
Masters	-0.09	0.20	-0.84	0.09	0.45	0.06	1.00	0.70	-0.34	-0.27
Masters toc	-0.06	0.38	-0.76	0.41	0.55	0.02	0.70	1.00	-0.18	0.00
R&D	-0.42	-0.30	0.21	-0.03	0.14	-0.05	-0.34	-0.18	1.00	-0.02
Weight	0.29	0.30	0.13	0.18	0.04	0.12	-0.27	0.00	-0.02	1.00

Doctoral Segments: PostDoctoral Students

u[y]	1.00	0.38	-0.87	0.53	0.49	0.37
u[y] si	0.38	1.00	-0.28	0.02	0.23	0.25
Fac	-0.87	-0.28	1.00	-0.75	-0.66	-0.18
R&D	0.53	0.02	-0.75	1.00	0.91	0.30
R&D si	0.49	0.23	-0.66	0.91	1.00	0.30
Weight	0.37	0.25	-0.18	0.30	0.30	1.00

Asymmetry in the Residuals

We expected the residuals for both the finance and production equations to be skewed to the right: i.e., that departments view slack in the constraints less seriously than violations. The rightward skewness does in fact occur in every case—in all the equations for both the doctoral and the non-doctoral segments. Figure 3.1 shows the frequency distributions for the four doctoral-sector equations. The distributions for the non-doctoral equations are similar to the "Faculty" and "Finance" panels.

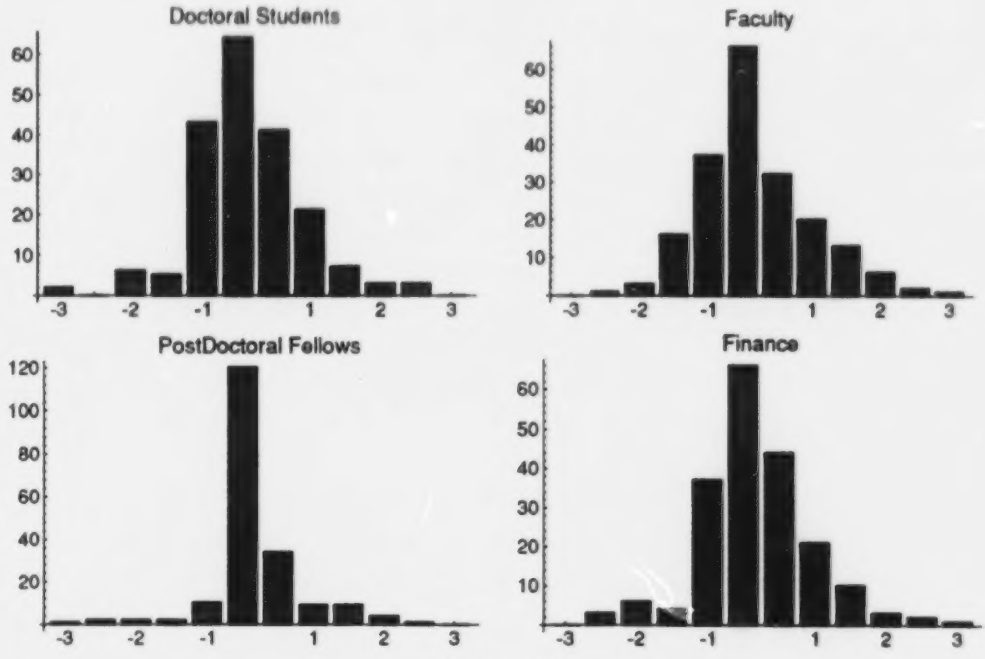


Figure 3.1
Frequency Distributions of Regression Residuals: Doctoral Segments
(x-axis represents standard deviations of the residuals)

Quantifying statistics for the asymmetries are provided in Table 3.8. The first column contains the fraction of the total sum of squares represented by observations with positive residuals, while the second column gives the

values of m^+ described in connection with (3.8). Between 60% and 70% of the sum of squares occurs on the positive side of the frequency distribution. The

Table 3.8
Asymmetry Coefficients

	fr[sse*]	m^*
Doctoral segments		
Doctoral students	0.692	0.264
Faculty	0.730	0.232
Postdoctoral fellows	0.725	0.156
Non-doctoral segments		
Faculty: segment 11	0.668	0.382
Faculty: segment 12	0.720	0.541
Faculty: segment 13	0.734	0.536

positive skewness reduces the weight multipliers (m^+) for the doctoral segments to between 0.15 and 0.26, which implies that the penalties for slack amount to only 18% to 36% of those for constraint violation (0.14/0.86=0.16 and 0.26/0.74=0.36). The figures for m^+ in the non-doctoral segments are larger than those for the doctoral segment, and in two of the three cases it appears that the penalties for slack slightly exceed those for constraint violation ($m^+ \geq 0.5$). The asymmetry coefficient, however, is not really relevant with only a single decision variable.

Simulation Sensitivity Analysis

What do the statistical results imply about departmental choice behavior? No single set of coefficients can provide the information needed to answer this question. All the equations interact, and the result can only be obtained by actually performing the optimization set forth in equation (3.3).

Figures 3.2 and 3.3 (positioned at the end of the paper) depict what happens as each independent variable is shifted ±30% relative to its observed segment total. "Price" refers to the coefficients in the revenue equation, and "quantity" to the exogenous variables. The graphs show the populations of doctoral students, faculty, and postdoctoral fellows (faculty only for the non-doctoral segments), summed over the segments.

The directions of the various effects are nearly always as expected. They reassure us that the model is performing well: no simulation-disrupting pathologies are evident.

While the graphs provide a useful overview of the model's sensitivity, they do not provide accurate quantification. Hence we calculated a "sensitivity elasticity" for each pair of variables—the percentage change in the decision variables per one-percent change in the independent variable. The sensitivity elasticities are presented in Table 3.9.

Doctoral and postdoctoral enrollments are elastic with respect to fixed revenue (their elasticities are greater than one in absolute value). Departments add most to doctoral enrollment when revenue grows, with the percentage of faculty additions being less than half that for doctorates. All the other variables are inelastic. Non-doctoral departments add faculty at a greater rate than doctoral-granting ones, but the greater cost of faculty keeps the size of the increment relatively low. The non-doctoral departments are relatively sensitive to the price of faculty (c_F in the revenue function) and to the prices and quantities of general baccalaureate degrees. Faculty size in the doctorate

Table 3.9
Simulation Elasticities
(percent change in column variable per one percent change in row variable)

	Doctoral			Non-doctoral
	Doc	*Fac*	*PostDoc*	*Fac*
Fixed revenue	0.202	0.023	1.036	0.788
Price: *Doc*	–0.309	–0.061	–1.086	–
Price: *Fac*	–0.577	–0.169	–1.678	-0.804
Price: *PostDoc*	–0.098	–0.019	–0.647	–
Price: *BachAll*	0.392	0.131	1.338	0.638
Price: *Bach*	0.116	0.031	0.611	0.066
Price: *Masters*	0.000	0.000	0.000	0.006
Price: *R&D*	0.269	0.059	1.054	0.068
Quantity: *BachAll*	0.416	0.421	0.191	0.638
Quantity: *Bach*	0.125	0.121	0.138	0.066
Quantity: *Masters*	–0.015	0.019	–0.069	0.006
Quantity: *R&D*	0.270	0.221	0.339	0.068

segments depends most heavily on *BachAll*, and then on *Price:BachAll* and *Price:R&D*. Doctoral enrollment depends most heavily on the price of faculty—perhaps largely due to an income effect, since faculty account for the largest part of the department's salary budget. Next comes the price of

doctorates themselves, the price and quantity of general bachelors degrees, and the amount of R&D. Postdoctoral enrollment depends mainly on R&D quantity, and then on the prices of faculty, doctoral students, and R&D.

III. Results for All Fields

Having completed our in-depth analysis of Physics, we now turn our attention to parameter comparisons across all 12 of the scientific and engineering fields included in our dataset. The scale of the 12-field analysis task precludes detailed discussion, but we do offer some general conclusions. Additional interpretations are sure to come. Tables 3.10 through 3.13, positioned at the end of the chapter, summarize the estimation results for both the doctoral and non-doctoral segments. Appendix Tables 3.A10 through 3.A19 report the actual coefficients and their standard errors.

The model continued to work well when extended beyond the Physics dataset. As can be seen from the Appendix tables, the R-squares generally exceed 50%, and most of the coefficients are statistically significant.

Financial Effects

Table 3.10 (positioned at the end of the Chapter) presents the financial-equation results: the variable revenue attributed to each of the four drivers, plus fixed revenue. The first three lines in each block presents the coefficients for the average doctoral segment (for which *S-index*=0), the segment with the largest *S-index*, and the segment with the smallest *S-index*. The next three lines present the data for the three non-doctoral segments: private liberal arts colleges, private comprehensive institutions, and public non-doctoral institutions. The *BachAll* and *R&D* coefficients have been multiplied by 1000 and the *Bach* and *Masters* coefficients by 10 to improve readability. Blanks indicate the main effect did not enter the equation for the given field, and equality across the doctoral segments indicates that *S-index* and *toc* did not enter. The fields are arrayed in the order found to be efficacious in Chapter 2: first the sciences, then math and the social sciences, and then engineering and computer science.

Our first observation is that variable revenue for *BachAll* tends to be larger in fields with heavy general education loads than in the more specialized fields. Noteworthy fields are Economics (except for the top doctoral segments), Mathematics, Physics (again except the top doctoral segments), Chemistry, Psychology, and Biology (in the non-doctoral segments). Engineering in the private comprehensive institutions stands out

as something of an exception, but this might be explained by the prevalence of engineering enrollments in these institutions. While other exceptions can be identified, the general pattern fits our expectations.

Bach presents less of a pattern, although there is some tendency for doctoral institutions to offer departments more variable revenue than their non-doctoral counterparts. *Masters* also appears idiosyncratic, doubtless in part because of the scarcity of masters degrees in many fields and segments. The R&D figures are fairly comparable across segments but once again exhibit considerable variability. Fixed revenues also show considerable variability. The figures represent an average over the institutions in each segment; the average is not driven by sample size but does depend on institutional size within each segment: this explains the larger figures for the doctoral segments. The tendency for departments to show fixed cost rather than fixed revenue is clear, however: 56 of the 72 coefficients are negative.

Endogenous Production Effects

Table 3.11 (at the end of the chapter) summarizes the utility and endogenous-variable results for the doctoral segments (the only ones where these effects are relevant). The utility presentation is couched in terms of ratios, since the absolute values of the utilities are indeterminate. The first block shows the ratio of doctoral to faculty utility; the second, the ratio of PostDoc to faculty utility; and the third, the ratio of PostDoc to doctoral utility. The blanks indicate fields for which the lowest segment's computed utility is negative: we set the utility coefficient to zero in each such case, but we note that in no case was the amount of negative excursion large.

Most institutions appear to value doctoral students more highly than faculty, at least as far as spending the marginal dollar is concerned. Of the 33 utility[*Doc*]/utility[*Fac*] coefficients, 28 are less than one and most are far less. A smaller fraction, 18 of 28 utility[*PostDoc*]/utility[*Fac*] coefficients are less than one. While one must be cautious about conclusions of this sort, it appears that departments tend to consider faculty numbers as being more tightly linked than doctoral students to the drivers, making the latter more discretionary and less proportional to the exogenous forces.

Not much needs be added to our discussion, in connection with Physics, about the effect of faculty numbers on postdoctoral enrollment. Faculty entered the postdoctoral production equation in only three fields: Physics, Psychology, and Computer Science. In each case, the effect is relatively small, and it is statistically significant only for Physics. We should note, though, that

deleting faculty from the equation in the other two fields causes sign problems elsewhere—the reason that we included them despite their low t-ratios.

Perhaps the most interesting generalization of the whole production-function study occurs with respect to the effect of faculty on doctoral students. We noted in the case of Physics that, for the most elite institutions, increasing doctoral enrollment actually reduces faculty numbers. We said that doctoral students appear as "producers" goods in the top Physics segment, whereas they tend to generate additional faculty numbers elsewhere. The second-to-last block in Table 3.11 shows that this effect holds in ten of the twelve fields and that in the other two fields (Geosciences and Psychology), the discrepancy is very small. In three fields (Biology, Electrical Engineering, and Computer Science), faculty and doctoral students turn out to be slight substitutes in production even in the average segment. This finding supports the conventional wisdom that our more elite universities rely on doctoral students as factors of academic production rather than as "clients" who require positive net inputs of faculty effort.

Exogenous Production Effects

The exogenous-variable effects are presented in Tables 3.12 and 3.13 (at the end of the chapter): the first summarizes the Faculty equation; the second, the Doctoral and Postdoctoral equations.

Note first that the marginal effect of general degrees upon faculty numbers is uniformly smaller in the doctoral segments than in the non-doctoral ones. This is true in every single segment-combination and field for which comparisons are possible. As stated earlier for Physics, we believe that the generally larger size of the doctoral institutions tends to dilute the general-degree effect on faculty. One may speculate, however, that the non-doctoral institutions budget departments "closer to the market," thus setting in train a series of economic and cultural forces that could account for the larger *BachAll* effect.

Looking at the *BachAll* effect across fields, we see that Mathematics presents by far the largest coefficients for both the doctoral and the non-doctoral segments. Mathematics is, of course, the field with the largest general-education responsibility. Chemistry, Biology, Physics, and Biology—also big general-education fields—also present relatively large coefficients. Finally, we note the large coefficients for engineering in the private

comprehensive institutions, a finding also seen in Table 3.10 for the financial equation.

The *Bach* effect shows a much narrower range of variation than that for BachAll, and the patterns are not as strong. Ten in-major bachelors degrees seems to produce between one and two faculty members for the non-doctoral fields, with slightly fewer for the doctoral segments. The doctoral-segment effects are again smaller—this time in about 9 of the 12 fields—but the differences are not as sharp as for *BachAll*.

Masters enters the doctoral-segment faculty equation for Economics, Psychology, Computer Science, and all the engineering fields, but in only two of the five remaining fields. We believe that the first group of fields is more likely to offer terminal masters degrees or degrees with a stronger employment payoff (absent the doctorate) than Mathematics and the basic science fields. The effect is sporadic for the non-doctoral segments, in part because the number of masters degrees there is small. *Masters* tends to be somewhat larger than *Bach*, especially in the fields with more independent masters programs, though the pattern is by no means definitive.

R&D demonstrates some strong interpretable patterns. First, the figures for the non-doctoral segments tend to be greater—and in some cases considerably greater—than those for the doctoral segments. Doubtless this is due to the greater importance of sponsored research for non-doctoral institutions, when such research occurs. The data show that faculty lines follow sponsored-research success to a materially greater extent in the non-doctoral than in the doctoral segments. One can say that the non-doctoral institutions "reward" grant-getting, either with general-funds-supported faculty positions or by allowing faculty expansion based on soft money, to a greater extent than their doctoral counterparts.

Looking across fields, we see that the largest effect by far occurs in Mathematics. We speculate that Mathematics "wins" the most faculty lines because equipment, supplies, and non-faculty labor compete less for the sponsored research dollar than they do in lab-intensive fields. The fact that Economics also ranks high supports this notion, though one may question the rankings of Biology, Chemistry, and Physics. We would guess that Electrical Engineering is the most equipment-intensive field in our set, and its coefficient is the lowest among the doctoral-segments. Only 49 institutions comprise the private comprehensive dataset for Electrical Engineering, so the very large figure, 72.9, should not be taken too seriously even though it is statistically significant. We also note that *R&D*[*Fac*] produces our most

striking rogue result: the coefficient for Psychology in the top Doctoral segment. We have not been able to identify the cause, but we did zero out this coefficient in the simulation input file.

Table 3.13 presents the exogenous-variable effects for the doctoral and postdoctoral equations in the doctoral segments. The most interesting pattern here shows general bachelors degrees (*BachAll*) as calling forth many more doctoral students than we saw in the case of faculty—all the more so in the top as opposed to the low segment. A look back to Appendix Table 3.A-16 shows that the main effect is both strongly positive and highly significant statistically, and that the same is true for the S-index term in all four cases where it could be brought into the equation. This is consistent with the idea, mentioned a number of times already, that doctoral students are very important for general-education teaching, especially in the elite segments.

Bach and *R&D* also exert considerable leverage on doctoral student numbers. The main effects generally exceed those in the Faculty equation, and they are highly significant statistically. The interactions of *R&D* with *S-index* are negative in 8 of the 9 fields where they could be brought into the equation. (The exception is Psychology, where the coefficient is strongly positive). This means that sponsored research funding "buys" more doctoral students in the non-elite segments, probably because the elite institutions are more likely to build doctoral numbers into their base budgets. Finally, we note that increases in *R&D* produce only modest postdoctoral numbers in most fields, the exceptions being Biology and Chemistry, and to a lesser extend Physics, which are known heavy postdoctoral employers.

Asymmetry

The theory behind our model suggests that the sums of squares of the structural-equation residuals will be skewed positively and that the weight for positive deviations described by equation will be less than 0.5. All the Physics segments were consistent with the skewness hypothesis, and all three doctoral segments have small weights. The weights for two of the three non-doctoral segments were slightly greater than 0.5, but this matters little because these segments involve no tradeoffs among endogenous variables.

Table 3.13 extends the analysis to all 12 fields, and the results strongly support the asymmetry hypotheses. Only one of the 72 segment-field combinations evidences negative skewness, indicated by a $f[sse^+]<0.5$ ($f[sse^+]$ is the fraction of the total sum of squares represented by positive residuals). Only two of the 36 Doctoral-segment weights is less than 0.5. (The doctoral-

segment weights feed directly into the simulation.) The figure is higher for the non-doctoral segments (14 reversals out of 36 cases), but, as indicated above, this is relatively unimportant. The asymmetry findings add to the store of evidence supporting the model's overall credibility.

IV. Conclusion

This chapter describes our model for the effects of degree production and sponsored research funding on doctoral and post-doctoral enrollment and faculty size. In Section I, we formulated the structural equations and developed appropriate estimators. Section II uses the algorithms to generate parameter estimates and simulate departmental resource allocation behavior for Physics. Section II extends the Physics parameter estimations to all 12 fields included in our science and engineering dataset.

Both the statistical and simulation results are satisfactory. The estimated equations fit the data well; nearly all the coefficients have the expected sign, and most of them are statistically significant. The estimates are generally stable as variables are added to and subtracted from the equations, and the estimates tend to show consistent patterns across fields. While the simulation algorithm had to be modified to enforce a two-sided financial constraint, the amended version produces credible simulation results. Hence we conclude that the model is sufficiently robust to use in our simulation of the supply and demand for science and engineering doctorates.

We end with a few "loose ends" that deserve followup as part of a future project. Most important is to look the reasons that an enforced two-sided financial constraint is required for simulation. The model's built-in weighting scheme isn't working as we had expected, and the weights should be traced back through the estimator to make sure everything is consistent. Enforcing the financial constraint seems appropriate enough for simulation purposes, since departments surely should be treated as shunning deficits but spending all the money they can get. The approach, however, is not as theoretically attractive as the one-sided model.

The second task would be to replace the current piecewise-linear LP maximizing procedure with a proper quadratic programming algorithm. This would speed up computation, reduce complexity, and probably produce a better result. This is not a conceptually difficult task, but finding or developing a function that would run in or could be called from Mathematica proved to be beyond our capability on this project.

The third task involves further exploration of the parameter space for both the financial and production equations, especially for the fields other than Physics where we had time for only a limited amount of testing. Once again, this is not conceptually difficult, but this task is sufficiently time-consuming to be beyond the hands-on capacity of the principal investigators. A more extensive search for possible rogue datapoints should take place prior to further empirical analysis.

References

Atkinson, Richard C. [1990]. "Supply and Demand for Scientists and Engineers: A National Crisis in the Making," *Science* 248 (April 27), pp. 425-432.

Beightler, Charles S., Don T. Phillips and Douglas J. Wilde [1979]. *Foundations of Optimization*. Englewood Cliffs, NJ: Prentice-Hall, Inc.

Bowen, Howard R. [1980]. *The Costs of Higher Education: How Much Do Colleges and Universities Spend Per Student and How Much Should they Spend?* San Francisco: Jossey-Bass.

Hillier, Frederick S. and Gerald J. Lieberman [1990]. *Introduction to Operations Research*. Fifth ed., New York: McGraw-Hill Publishing Company.

Hopkins, David S. P. and William F. Massy [1981]. *Planning Models for Colleges and Universities*. Stanford, CA: Stanford University Press.

James, Estelle [1982]. "How Nonprofits Grow: A Model." *Journal of Policy Analysis*, 2, pp. 350-366.

James, Estelle [1990]. "Decision Processes and Priorities in Higher Education." In Stephen A. Hoenack and Eileen L. Collins (Eds.), *The Economics of American Universities*, pp. 77-106. Albany, NY: SUNY Press.

Massy, William F., Andrea Wilger and Carol Colbeck [1994]. "Overcoming 'Hollowed Collegiality'." *Change* (January-February), pp. 10-20.

Notes

[1]Atkinson [1990].

[2]Hopkins and Massy [1981]; see also James [1982], pp. 350-366, and James [1990], pp. 77-106.

[3]Computer Aided Science Policy Analysis and Research Database System (CASPAR), developed for the National Science Foundation by Quantum Research, Bethesda, MD.

[4]We have data on the number of faculty in 1980 for doctoral-granting institutions, but such data do not exist for the non-doctoral-granting departments. For them, we use total science and engineering personnel as a surrogate for faculty. Since the non-doctoral institutions have little sponsored research, it is likely that most S&E personnel do in fact represent faculty.

[5]Bowen [1980].

[6]See annual report in the *Chronicle of Higher Education* listing faculty salaries.

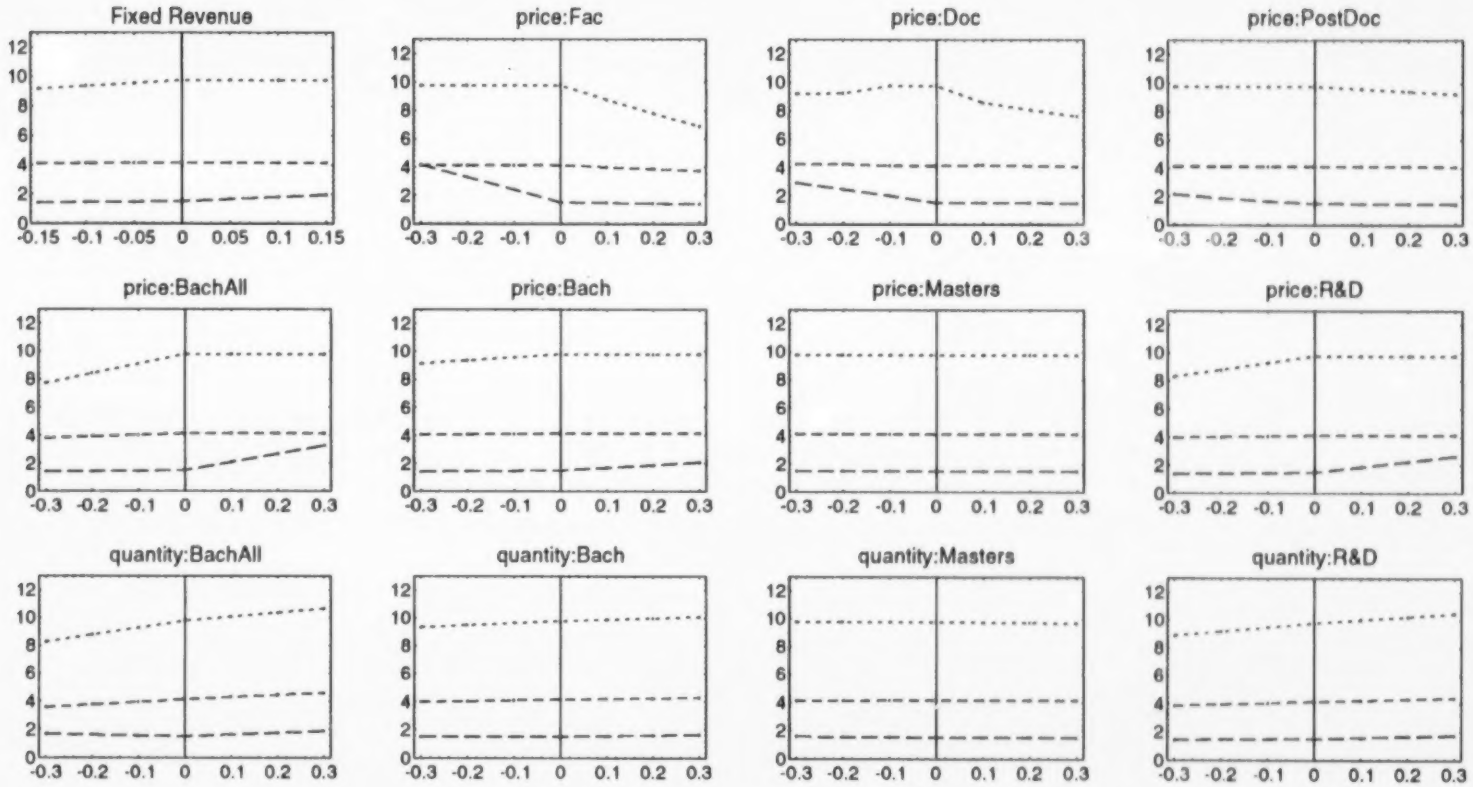
[7]Hillier and Liberman [1990], p. 271.

[8]Beightler, Philips, and Wilde [1979], p. 228.

[9]Hillier and Lieberman [1990], p. 528.

[10]Hopkins and Massy [1981], Chapter 3.

Figure 3.2
Sensitivity Analysis: Doctoral Segments*



Legend:
top curve = doctoral students
middle curve = faculty
bottom curve = postdoctoral fellows

*x-axis shows proportional change from baseline; y-axis shows total population (multiply by 1000).

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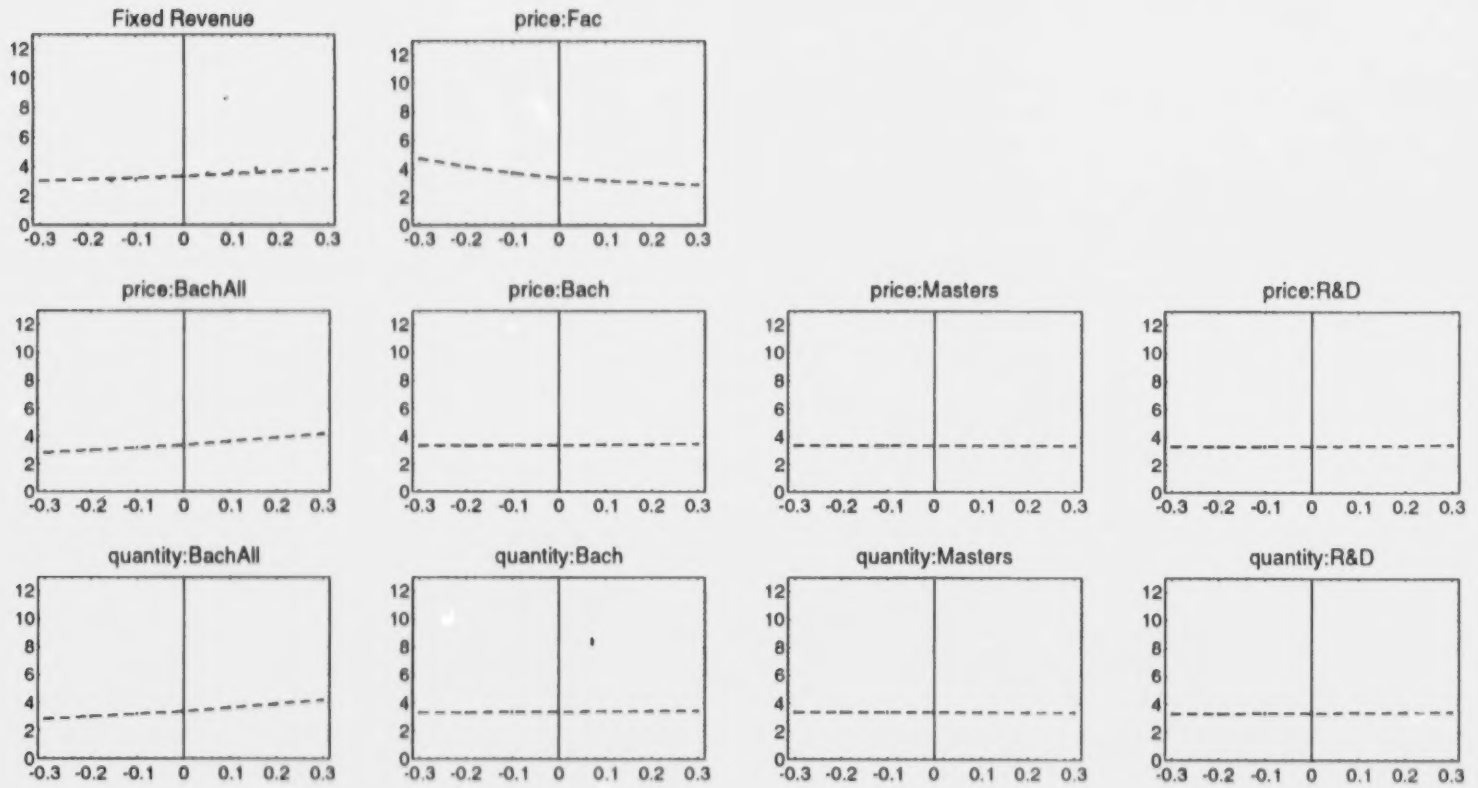
Figure 3.3
Sensitivity Analysis: Non-doctoral Segments*



Legend:
curve = faculty
curves for doctoral students and
postdoctoral fellows are not applicable

*x-axis shows proportional change from baseline; y-axis shows total population (multiply by 1000).

Table 3.10. Fixed and Variable Revenues

	Segment	BIOS	CHEM	PHYS	GEOS	MATH	ECON	PSYC	CENG	CIVL	ELEC	MECH	CSCI
Bachall	avg doc		123.6	184.2	104.2	218.5	203.6	127.9		92.0			67.3
(000)	top doc		134.7	88.7	104.2	218.5	95.9	127.9		92.0			67.3
	low doc		132.0	235.6	104.2	218.5	223.6	127.9		92.0			67.3
	pr LAC	187.4	143.2	145.1	105.5	165.1		228.8		52.2		-50.7	28.3
	pr comp	101.0	166.0	136.4	27.5	271.2	191.8	175.4	216.0		191.8	300.2	63.5
	public	262.6	185.1	170.2	117.0	347.7	104.9	220.2	6.2	93.9	104.9	78.2	52.2
Bach	avg doc	177.1	12.7	148.4	63.8	138.7	46.7	16.3	28.1		120.0	47.1	31.5
(0)	top doc	150.8	36.7	208.7	275.9	150.0	4.1	16.3	21.6		120.0	47.1	31.5
	low doc	191.3		115.9	-9.5	155.9	54.7	16.3	21.6		120.0	47.1	31.5
	pr LAC	7.8	26.0	32.5	31.9	33.7	40.2	6.7	99.1	52.6	40.2	26.0	21.2
	pr comp	25.5	42.4	91.9	69.6	33.6	31.4	38.1	6.6	57.6	31.4	19.5	34.4
	public	22.2	66.0	42.0	40.8	31.8	41.5	37.6	33.6	65.1	41.5	44.0	28.1
Mast	avg doc							108.9	311.5	310.2		296.1	106.0
(0)	top doc							444.9	311.5	368.4		460.2	329.9
	low doc							49.8	311.5	299.4		264.1	91.3
	pr LAC		109.8	1149.8		46.9		26.4				10.6	
	pr comp	47.2	11.0	287.9		48.7		35.0	126.6	15.2			14.1
	public	115.7	48.4		0.8			18.6	132.7			110.9	11.5
R&D	avg doc	403.3	552.0	245.6	158.0	977.0	446.4	512.8	310.5	446.4	702.0	263.2	228.2
(000)	top doc	281.7	526.3	77.3	-78.6	977.0	284.0	512.8	263.7	96.7	325.0	-4.2	-13.8
	low doc	468.6	574.1	254.1	182.0	977.0	259.6	512.8	263.7	511.4	673.4	315.4	244.0
	pr LAC	435.1	418.2		25.3	1890.9		520.4				1436.4	
	pr comp	675.6	691.5	288.8	193.1	233.7	1860.9	607.2	43.2		1860.9	475.3	289.9
	public		370.4	680.7	62.7	860.1			198.2			325.8	217.6
Fixed	avg doc	97.9	-373.0	-118.3	-333.7	-52.3	-282.5	-824.3	-250.1	-155.3	-88.5	-112.4	-321.1
(avg)	top doc	-467.4	-351.3	1431.6	389.4	-214.2	1066.3	-495.7	-120.0	-183.7	901.1	-495.9	-224.9
	low doc	401.2	-374.7	-380.6	-375.9	-40.8	-576.9	-822.4	-266.8	-209.7	-355.7	-132.9	-301.5
	pr LAC	-11.9	-5.0	8.7	-11.1	-7.8	-39.0	1.2	-102.9	-33.0	-39.0	-19.2	-16.6
	pr comp	-17.6	1.6	6.6	-11.8	22.2	-14.5	38.5	-22.2	0.5	-14.5	39.0	-4.5
	public	-46.6	-24.2	-13.5	-1.9	8.4	-17.8	-18.8	32.4	-36.3	-17.8	-23.7	-11.9

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Table 3.11. Utility and Endogeneous Effects

	Segment	BIOS	CHEM	PHYS	GEOS	MATH	ECON	PSYC	CENG	CIVL	ELEC	MECH	CSCI
Utility	avg doc	0.08	0.08	0.14	0.18	0.28	0.11	0.27	0.17	0.16	0.04	0.13	0.08
Doc/Fac	top doc	0.08	0.08	1.17	1.73	0.85	0.92	1.57	0.93	1.08	0.26	0.70	0.99
	low doc	0.08	0.08	0.01	0.03	0.11		0.04	0.02			0.02	0.03
Utility	avg doc	0.99	0.20	0.05	0.51	0.50	0.18	0.11	0.37	0.26	0.31	0.31	0.16
PD/Fac	top doc	0.99	1.07	2.57	4.45	2.97	1.20	4.27	0.72	1.36	2.43	1.90	2.92
	low doc	0.99			0.11				0.31	0.05			
Utility	avg doc	12.99	2.34	0.37	2.77	1.82	1.64	0.40	2.21	1.61	8.25	2.38	1.93
PD/Doc	top doc	12.99	12.66	18.12	24.24	10.75	10.96	15.76	4.28	8.49	64.75	14.65	34.62
	low doc	12.99			0.60				1.81	0.33			
Endogen	avg doc			0.303				0.082					0.013
PD[Fac]	top doc			0.303				0.082					0.013
	low doc			0.303				0.082					0.013
Endogen	avg doc	-0.010	0.081	0.184	0.166	0.093	0.061	0.032	0.001	0.003	-0.058	0.032	-0.006
Fac[Doc]	top doc	-0.250	-0.045	-0.175	0.012	-0.168	-0.062	0.009	-0.102	-0.061	-0.153	-0.076	-0.042
	low doc	0.119	0.118	0.231	0.138	0.168	0.084	0.036	0.021	0.015	-0.039	0.054	-0.004

Table 3.12. Exogeneous Effects: Faculty

	Segment	BIOS	CHEM	PHYS	GEOS	MATH	ECON	PSYC	CENG	CIVL	ELEC	MECH	CSCI
Bachall	avg doc		1.683	2.847		6.138	0.735	2.124		0.715	2.064		1.192
(000)	top doc		1.683	2.847		6.138	0.735	2.124		0.715	2.064		1.192
	low doc		1.683	2.847		6.138	0.735	2.124		0.715	2.064		1.192
	pr LAC		9.427	8.354	6.222	10.763						0.386	2.919
	pr comp	8.067	10.717	7.639	1.796	19.973	8.093	10.793	6.484	1.590	8.093	12.952	6.321
	public	9.404	7.269	6.596	6.556	14.515	4.167	9.545	1.287	2.856	4.167	3.328	3.153
Bach	avg doc	3.441	0.077	1.876	0.626	2.669	0.437	0.451	0.478	0.344	0.490	0.836	0.480
(0)	top doc	3.441	0.077	1.876	0.626	2.669	0.437	0.451	0.478	0.344	0.490	0.836	0.480
	low doc	3.441	0.077	1.876	0.626	2.669	0.437	0.451	0.478	0.344	0.490	0.836	0.480
	pr LAC	1.132	1.311	2.073	1.299	1.755	1.387	1.232	1.256	1.660	1.387	0.931	1.200
	pr comp	1.863	2.145	3.454	2.841	1.076	1.090	2.426	0.901	2.274	1.090	0.479	1.377
	public	1.335	3.005	1.077	1.529	1.862	1.364	1.530	1.044	3.291	1.364	1.395	1.212
Mast	avg doc	0.987		0.827			1.471	1.192	2.977	3.003	5.944	1.581	1.432
(0)	top doc	0.987		1.323			1.333	1.192	2.977	3.156	5.944	4.655	1.432
	low doc	0.987		0.559			1.333	1.192	2.977	3.156	5.944	0.981	1.432
	pr LAC	1.390	3.854	7.585		2.689		1.336				0.549	
	pr comp	2.637		12.601	1.427			2.516					0.543
	public	6.710	1.229		0.774	1.471		0.372	2.279			1.065	
R&D	avg doc	6.432	5.110	2.013	0.370	22.270	6.344	9.730	3.761	3.629	0.646	2.877	2.242
(000)	top doc	6.432	5.110	2.013	0.370	22.270	6.344	-25.778	3.761	3.629	0.646	0.060	2.242
	low doc	6.432	5.110	2.013	0.370	22.270	6.344	15.978	3.761	3.629	0.646	3.427	2.242
	pr LAC	27.150	14.182	17.208		96.072		44.983					
	pr comp	26.384	27.009	11.466	12.790	5.923	72.907	9.638	5.854		72.907	19.904	3.256
	public	2.766	12.677	34.190	2.683	88.541	5.106	7.261	1.281		5.106	19.548	17.854

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Table 3.13. Exogeneous Effects: Doctoral and PostDoctoral Students

	Segment	BIOL	CHEM	PHYS	GEOS	MATH	ECON	PSYC	CENG	CIVL	ELEC	MECH	CSCI
Doctoral Students													
Bachall	avg doc	20.063	13.316	9.098	12.110	11.827	13.435	14.333		8.481			9.374
(000)	top doc	64.665	32.573	34.569	12.110	29.031	13.435	14.333		8.481			9.374
	low doc	-3.864	8.572	5.728	12.110	6.899	13.435	14.333		8.481			9.374
Bach	avg doc	12.187		6.273	8.492	4.716	0.883		3.669	2.466	7.854	3.968	6.322
(0)	top doc	4.273		6.273	8.492	4.716	0.883		1.748	2.466	7.854	6.112	6.322
	low doc	16.433		6.273	8.492	4.716	0.883		4.048	2.466	7.854	3.550	6.322
R&D	avg doc	11.934	29.182	11.627	4.207	54.846	31.457	30.002	26.117	41.395	64.194	30.317	
(000)	top doc	10.883	21.198	4.178	4.207	54.846	17.233	142.280	10.287	23.359	21.557	1.732	
	low doc	12.498	31.150	12.613	4.207	54.846	34.106	10.248	29.236	44.751	64.343	35.896	
PostDoctoral Students													
R&D	avg doc	7.093	9.190	2.308	0.487	1.930	0.539	0.884	1.144	1.013	0.272	0.184	
(000)	top doc	7.710	10.306	1.438	0.141	3.300	1.491	0.884	4.663	0.721	0.194	0.184	
	low doc	6.761	8.915	2.423	0.522	1.538	0.361	0.884	0.450	1.067	0.287	0.184	

Table 3.A-1
Endogeneous Variables by Segment

	N	Doc	Fac	PostDoc
		Private Doctoral Segments		
1	3	592	118	170
2	6	804	201	185
3	9	637	214	88
4	52	1222	749	151
		Public Doctoral Segments		
5	5	734	144	98
6	4	795	191	93
7	6	999	302	215
8	14	1040	355	152
9	17	981	460	136
10	84	1963	1397	210
		Non-Doctoral Segments		
11	358	0	790	0
12	207	0	707	0
13	304	0	1872	0

Table 3.A-2
Exogeneous Variables by Segment

	BachAll	Bach	Masters	R&D	S-index
		Private Doctoral Segments			
1	2976	141	57	58050	0.799
2	8050	104	111	42291	0.408
3	11565	94	73	19519	0.207
4	62817	320	142	26833	-0.048
		Public Doctoral Segments			
5	18731	113	109	22385	0.462
6	15508	112	85	22021	0.335
7	29177	203	90	50908	0.239
8	38444	243	120	31394	0.158
9	55005	214	101	26470	0.026
10	177044	400	230	33081	-0.106
		Non-Doctoral Segments			
11	73492	480	2	1984	na
12	90621	255	12	5402	na
13	256084	693	114	6215	na

Table 3.A-3
Definitions of m and f[theta]

m (all k: substitute actual or reduced-form y as appropriate)

```
(y1, y2, y3, x1, x2, x3, x4, z1, z2, y1*z1, y1*z2, y2*z1, y2*z2, y3*z1, y3*z2, x1*z1, x1*z2, x2*z1, x2*z2,
  x3*z1, x3*z2, x4*z1, x4*z2, z1*z2, z1^2, z2^2, y1*z1^2, y1*z2^2, y2*z1^2, y2*z2^2, y3*z1^2, y3*z2^2,
  x1*z1^2, x1*z2^2, x2*z1^2, x2*z2^2, x3*z1^2, x3*z2^2, x4*z1^2, x4*z2^2, y1*z1*z2, y2*z1*z2, y3*z1*z2,
  x1*z1*z2, x2*z1*z2, x3*z1*z2, x4*z1*z2)
```

*m*f1[theta]*

```
- 2*m1*w1 + 2*b15*m16*w1 + 2*b18*m22*w1 + 2*b11*m4*w1 + 2*b12*m5*w1 + 2*b14*m7*w1 -
  2*g21^2*m1*w2 - 4*g21*g24*m10*w2 + 2*g24*m12*w2 - 2*b21*g24*m16*w2 - 2*b22*g24*m18*w2 + 2*g21*m2*w2 -
  2*b23*g24*m20*w2 - 2*b2$11*g21*m21*w2 - 2*b24*g24*m22*w2 - 2*g24^2*m27*w2 - 2*b21*g21*m4*w2 - 2*b2$11*g24*m46*w2 -
  2*b22*g21*m5*w2 - 2*b23*g21*m6*w2 - 2*b24*g21*m7*w2
```

*m*f2[theta]*

```
2*g21*m1*w2 + 2*g24*m10*w2 - 2*m2*w2 + 2*b2$11*m21*w2 + 2*b21*m4*w2 + 2*b22*m5*w2
 + 2*b23*m6*w2 + 2*b24*m7*w2 - 2*g32^2*m2*w3 - 2*b38*g32*m22*w3 + 2*g32*m3*w3 - 2*b34*g32*m7*w3
```

*m*f3[theta]*

```
2 g32 m2 w3 + 2 b38 m22 w3 - 2 m3 w3 + 2 b34 m7 w3
```


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Table 3.A-4
Reduced Form: Doctoral Students
Doctoral Segments

	Estimate	SE	TStat	PValue
constant	-0.364023	4.06295	-0.0895958	0.928705
Bachall	0.00733519	0.0015182	4.8315	0
Bach	0.449033	0.300051	1.49652	0.136222
Mast	3.00976	0.483285	6.22771	0
RDAdj	0.00666765	0.00111154	5.99859	0
BachallSi	0.0314374	0.00594491	5.28812	0
BachSi	-1.39904	1.10821	-1.26244	0.20838
MastSi	-0.365766	1.40025	-0.261215	0.794217
RDAdjSi	-0.00253348	0.00295193	-0.858245	0.391868
BachallPri	-0.00344219	0.00366064	-0.940326	0.348276
BachPri	-0.213223	0.478883	-0.445251	0.656659
MastPri	-0.135795	0.638541	-0.212664	0.831823
RDAdjPri	0.00281971	0.00166229	1.69628	0.0915145
Si	4.24966	19.6711	0.216036	0.829198
Pri	7.13998	6.28884	1.13534	0.257701

RSquared -> 0.885948, EstimatedVariance -> 404.218,

Table 3.A-5
Reduced Form: Faculty
Doctoral Segments

	Estimate	SE	TStat	PValue
constant	-2.95764	1.50323	-1.96752	0.0506183
Bachall	0.00398497	0.000561714	7.0943	0
Bach	0.0865861	0.111015	0.779952	0.436416
Mast	0.98717	0.178809	5.52081	0
RDAdj	0.0028378	0.000411253	6.90037	0
BachallSi	-0.00340262	0.00219954	-1.54697	0.123579
BachSi	0.177367	0.410021	0.432581	0.665823
MastSi	-0.72829	0.518073	-1.40577	0.16147
RDAdjSi	-0.00473542	0.00109217	-4.33577	0.0000238267
BachallPri	-0.00257692	0.00135438	-1.90265	0.0586395
BachPri	0.166619	0.17718	0.940394	0.348242
MastPri	-0.308875	0.236251	-1.3074	0.192699
RDAdjPri	0.00140567	0.000615024	2.28556	0.0234143
Si	1.06414	7.27802	0.146213	0.883912
Pri	3.95877	2.32679	1.70139	0.0905497

RSquared -> 0.748665, EstimatedVariance -> 55.3334,

Table 3.A-6
Reduced Form: PostDoctoral Fellows
Doctoral Segments

	Estimate	SE	TStat	PValue
constant	2.30342	1.53153	1.504	0.134285
Bachall	0.00162072	0.000572287	2.83201	0.00513802
Bach	0.0262481	0.113104	0.23207	0.81674
Mast	0.24573	0.182174	1.34887	0.179027
RDAdj	0.00240649	0.000418994	5.74351	0
BachallSi	0.000656161	0.00224093	0.292807	0.769998
BachSi	-0.166196	0.417739	-0.397847	0.691202
MastSi	1.03273	0.527824	1.95659	0.0519009
RDAdjSi	-0.00259945	0.00111273	-2.3361	0.0205575
BachallPri	-0.000776453	0.00137988	-0.562698	0.574322
BachPri	0.0576155	0.180515	0.319173	0.749955
MastPri	-0.194954	0.240698	-0.809952	0.419008
RDAdjPri	0.00164022	0.0006266	2.61765	0.00958669
Si	0.739673	7.41501	0.0997535	0.920648
Pri	1.50074	2.37058	0.633067	0.527471

RSquared -> 0.717913, EstimatedVariance -> 57.4359

Table 3.A-7
Reduced Form: Faculty
NonDoctoral Segment 11

	Estimate	SE	TStat	PValue
constant	-0.719619	0.149492	-4.81376	0
Bachall	0.00386794	0.000899999	4.29772	0.00002237
Bach	0.148061	0.0254331	5.82158	0
Mast	1.34707	0.513437	2.62363	0.0090795
RDAdj	0.017181	0.00127056	13.5224	0
BachallSi	0.00207934	0.0010603	1.96109	0.0506589
Si	0.454479	0.244133	1.8616	0.0634946

RSquared -> 0.718514, EstimatedVariance -> 0.987003

Table 3.A-8
Reduced Form: Faculty
NonDoctoral Segment 12

	Estimate	SE	TStat	PValue
constant	-0.843284	0.545074	-1.5471	0.12342
Bachall	0.00290866	0.00193151	1.5059	0.133671
Bach	0.330287	0.0625864	5.2773	0
Mast	1.30534	0.310799	4.19993	0.00004018
RDAdj	0.0120136	0.0004031	29.803	0
BachallSi	0.00264972	0.00202298	1.30981	0.191762
Si	-0.612521	0.674966	-0.907485	0.365242

RSquared -> 0.876192, EstimatedVariance -> 3.01241

Table 3.A-9
Reduced Form: Faculty
NonDoctoral Segment 13

	Estimate	SE	TStat	PValue
constant	-0.80733	1.119	-0.721475	0.471185
Bachall	0.00390269	0.00458048	0.852027	0.394885
Bach	0.129407	0.0703929	1.83836	0.0670078
Mast	-0.149179	0.21841	-0.683021	0.495126
RDAdj	0.0299931	0.0020684	14.5006	0
BachallSi	0.00145324	0.00459524	0.316249	0.752035
Si	0.0553012	1.18199	0.0467864	0.962715

RSquared -> 0.712401, EstimatedVariance -> 11.317

Table 3.A-10. Financial Coefficients: Doctoral Segments

	BIOL	CHEM	PHYS	GEOS	MATH	ECON	PSYC	CENG	CIVL	ELEC	MECH	CSCI
Fixed	100.8 (268.4)	-366.2 (88.7)	-194.1 (108.5)	-305.3 (89.7)	-125.2 (103.9)	-319.0 (109.8)	-736.8 (157.3)	-242.6 (71.5)	-205.6 (150.4)	-214.7 (178.8)	-192.1 (75.1)	-291.4 (104.4)
Bachall(000)		144.4 (34.5)	235.6 (40.6)	104.2 (34.3)	218.5 (38.5)	203.6 (44.6)	127.9 (61.2)		92.0 (50.4)			67.3 (42.8)
Bachall Si		72.3 (92.8)				-197.1 (191.8)						
Bachall Toc		-59.9 (79.)	-146.8 (102.7)									
Bach(0)	183.4 (17.6)		115.9 (56.4)	16.8 (33.2)	181.4 (26.5)	46.7 (10.2)	16.3 (10.1)	21.6 (10.4)		120.0 (19.9)	47.1 (9.7)	31.5 (18.8)
Bach Si	-81.8 (189.3)			285.1 (95.4)	770.0 (625.6)	-78.1 (40.)						
Bach Toc	-17.9 (42.1)	36.7 (30.6)	92.8 (115.)	152.8 (59.3)	-120.6 (52.6)			19.4 (22.4)				
Mast(0)							108.9 (46.1)	311.5 (54.4)	310.2 (45.3)		296.1 (53.5)	106.0 (24.4)
Mast Si							926.8 (270.3)		108.6 (116.5)		244.5 (107.7)	368.8 (129.7)
Mast Toc												
R&D(000)	407.3 (41.5)	581.4 (49.9)	227.4 (27.7)	158.0 (19.1)	977.0 (94.2)	263.4 (88.1)	512.8 (75.2)	263.7 (78.6)	446.4 (146.1)	546.7 (117.4)	263.2 (75.)	228.2 (49.4)
R&D Si	-635.1 (224.7)	42.9 (103.4)	-252.8 (57.9)	-260.3 (45.8)		37.6 (294.3)			-652.5 (351.6)	-734.5 (165.5)	-398.5 (156.7)	-398.5 (125.9)
R&D Toc	-11.3 (53.9)	-84.9 (62.9)	52.0 (41.8)			513.4 (136.1)		139.2 (122.1)		451.5 (82.4)		
Si	-3113.0 (2419.4)	50.1 (324.5)	1763.2 (335.9)	764.3 (358.8)	-2544.3 (1966.2)	2536.0 (475.6)	1342.5 (1031.2)	236.1 (192.1)	40.9 (428.3)	816.9 (454.1)	-452.6 (302.4)	255.3 (602.)
Toc	-8.23 (430.38)	-19.82 (131.89)	216.48 (172.55)	-92.32 (116.33)	205.59 (135.42)	102.43 (109.17)	-245.49 (150.)	-22.04 (108.14)	161.90 (153.94)	367.15 (228.15)	234.75 (93.18)	-88.54 (110.49)
R-squared	78.4%	82.6%	83.1%	62.0%	72.3%	66.7%	52.0%	74.1%	75.3%	62.4%	78.1%	50.4%
N	201	201	199	181	201	201	201	124	144	156	152	184

Table 3.A-11. Financial Coefficients: Private Liberal Arts Colleges

	BIOL	CHEM	PHYS	GEOS	MATH	ECON	PSYC	CENG	CIVL	ELEC	MECH	CSCI
Fixed	-25.2	-17.3	-6.0	-12.8	-17.2	-6.7	-11.1	-40.6	-28.1	-46.9	-35.2	-18.8
	(3.5)	(2.5)	(3.4)	(4.4)	(2.8)	(5.1)	(4.1)	(4.3)	(9.5)	(11.6)	(13.1)	(2.6)
Bachall(000)	187.4	143.2	145.1	105.5	165.1	182.0	228.8		52.2		-50.7	28.3
	(24.4)	(15.4)	(17.2)	(20.)	(17.3)	(27.9)	(26.4)		(55.)		(54.2)	(12.5)
Bach(0)	7.8	26.0	32.5	31.9	33.7	16.7	6.7	99.1	52.6	40.2	26.0	21.2
	(2.1)	(2.8)	(8.7)	(5.)	(4.2)	(1.7)	(2.3)	(9.6)	(4.8)	(5.5)	(7.6)	(4.4)
Mast(0)		109.8	1149.8		46.9	100.4	26.4				10.6	
		(41.1)	(172.9)		(31.9)	(23.3)	(1.5)				(110.2)	
R&D(000)	435.1	418.2		25.3	1890.9	119.8	520.4				1436.4	
	(28.8)	(34.2)		(308.1)	(279.)	(202.9)	(138.7)				(2768.4)	
Si	36.8	33.9	40.3	4.7	25.6	36.6	33.9	-171.5	-13.5	21.8	44.0	6.2
	(5.4)	(3.7)	(4.7)	(5.9)	(4.1)	(6.8)	(5.6)	(27.3)	(17.1)	(17.6)	(19.4)	(3.5)
R-squared	69.4%	76.7%	61.1%	60.1%	67.5%	66.7%	72.1%	98.1%	91.5%	76.0%	65.8%	20.1%
N	460	450	357	141	447	364	413	7	22	22	86	200

Table 3.A-12. Financial Coefficients: Private Comprehensive Institutions

	BIOL	CHEM	PHYS	GEOS	MATH	ECON	PSYC	CENG	CIVL	ELEC	MECH	CSCI
Fixed	-31.9	-7.2	-0.3	-14.9	5.8	21.5	27.7	7.6	-21.6	-5.0	35.1	-11.6
	(13.3)	(11.2)	(6.4)	(4.5)	(12.7)	(18.5)	(17.2)	(36.4)	(29.6)	(36.1)	(100.4)	(10.4)
Bachall(000)	101.0	166.0	136.4	27.5	271.2	299.1	175.4	216.0		191.8	300.2	63.5
	(36.1)	(30.6)	(16.9)	(12.2)	(35.3)	(49.1)	(45.7)	(70.4)		(59.5)	(132.2)	(26.3)
Bach(0)	25.5	42.4	91.9	69.6	33.6	18.4	38.1	6.6	57.6	31.4	19.5	34.4
	(4.2)	(8.8)	(16.8)	(8.4)	(12.1)	(12.)	(5.8)	(11.9)	(9.4)	(7.5)	(18.6)	(4.9)
Mast(0)	47.2	11.0	287.9		48.7	103.0	35.0	126.6	15.2			14.1
	(14.9)	(46.2)	(83.4)		(42.6)	(58.4)	(4.7)	(37.1)	(18.2)			(6.2)
R&D(000)	675.6	691.5	288.8	193.1	233.7		607.2	43.2		1860.9	475.3	289.9
	(33.2)	(244.2)	(10.8)	(123.4)	(60.7)		(594.5)	(192.3)		(529.)	(122.2)	(109.5)
Si	26.4	16.3	12.7	5.7	30.3	18.4	19.9	-55.1	40.8	-17.5	7.2	13.2
	(17.2)	(13.7)	(8.2)	(5.7)	(16.)	(23.4)	(22.1)	(51.)	(35.2)	(41.7)	(112.9)	(12.9)
R-squared	74.6%	47.4%	85.7%	62.5%	52.8%	33.3%	48.9%	88.8%	76.6%	76.0%	61.1%	54.5%
N	234	229	206	85	233	204	220	14	32	48	357	138

Table 3.A-13. Financial Coefficients: Public Institutions

	BIOL	CHEM	PHYS	GEOS	MATH	ECON	PSYC	CENG	CIVL	ELEC	MECH	CSCI
Fixed	-49.0	-19.3	-7.2	-11.0	-25.3	-5.5	-17.0	-12.9	-9.6	-31.3	-28.4	-28.5
	(32.)	(13.2)	(12.5)	(17.8)	(24.4)	(20.8)	(25.5)	(54.6)	(59.8)	(60.1)	(52.4)	(17.6)
Bachall(000)	262.6	185.1	170.2	117.0	347.7	193.9	220.2	6.2	93.9	104.9	78.2	52.2
	(36.2)	(12.4)	(9.5)	(13.2)	(20.7)	(15.1)	(24.6)	(16.8)	(20.6)	(21.2)	(18.5)	(13.2)
Bach(0)	22.2	66.0	42.0	40.8	31.8	18.2	37.6	33.6	65.1	41.5	44.0	28.1
	(6.6)	(9.6)	(18.9)	(9.4)	(15.1)	(3.3)	(3.7)	(8.4)	(6.4)	(6.2)	(8.)	(3.8)
Mast(0)	115.7	48.4		0.8		83.1	18.6	132.7			110.9	11.5
	(32.3)	(41.3)		(33.3)		(43.9)	(6.9)	(77.9)			(90.9)	(13.8)
R&D(000)		370.4	680.7	62.7	860.1	442.4		198.2			325.8	217.6
		(61.9)	(56.1)	(4.1)	(448.6)	(126.8)		(209.5)			(188.)	(303.7)
Si	2.9	-6.0	-7.7	11.1	41.2	8.0	-2.2	55.3	-32.5	16.5	5.8	20.3
	(39.1)	(16.2)	(15.1)	(21.8)	(29.8)	(24.9)	(30.2)	(59.9)	(65.5)	(65.)	(57.1)	(20.7)
R-squared	59.6%	77.8%	73.1%	66.0%	68.6%	60.0%	77.2%	58.1%	70.7%	61.0%	65.8%	45.5%
N	314	314	303	239	312	289	294	32	82	88	86	239

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Table 3.A14. Utility and Endogeneous Effects: Doctoral Segments

	BIOL	CHEM	PHYS	GEOS	MATH	ECON	PSYC	CENG	CIVL	ELEC	MECH	CSCI
Utility Variables												
Faculty												
u[y](000)	9.601	18.661	12.470	9.136	7.205	29.153	18.538	14.829	27.369	94.463	21.277	25.699
	(3.779)	(2.084)	(1.775)	(1.406)	(1.486)	(2.578)	(3.61)	(1.553)	(4.296)	(19.777)	(2.090)	(3.425)
u[y] si			51.453			56.097		40.801				
			(21.011)			(38.019)		(17.152)				
Doctoral												
u[y](000)	0.730	1.573	1.766	1.678	1.992	3.189	5.027	2.505	4.373	3.544	2.758	2.168
	(0.664)	(0.273)	(0.235)	(0.333)	(0.359)	(0.443)	(0.483)	(0.355)	(1.349)	(0.859)	(0.560)	(0.559)
u[y] si			15.974	15.556	35.848	43.373	66.604	21.841	46.801	22.466	18.046	38.330
			(2.619)	(2.146)	(19.233)	(3.843)	(6.329)	(3.844)	(8.847)	(4.856)	(5.898)	(4.347)
Post-Doc												
u[y](000)	9.482	3.682	0.650	4.656	3.616	5.241	2.006	5.547	7.057	29.241	6.579	4.186
	(3.122)	(0.629)	(0.974)	(0.892)	(1.711)	(2.243)	(6.073)	(1.453)	(2.676)	(8.390)	(1.390)	(2.935)
u[y] si		23.385	39.218	39.622	153.721	54.402	213.039	9.949	56.100	218.472	50.389	116.712
		(6.44)	(5.819)	(9.666)	(82.160)	(26.680)	(52.499)	(15.587)	(24.016)	(55.760)	(11.704)	(19.125)
Endogeneous Variables												
Faculty												
Doc	-0.010	0.093	0.184	0.126	0.093	0.061	0.032	0.001	0.003	-0.058	0.032	-0.006
	(0.053)	(0.032)	(0.053)	(0.012)	(0.038)	(0.031)	(0.046)	(0.034)	(0.023)	(0.020)	(0.036)	(0.025)
Doc si	-1.335	-0.148	-0.449	-0.126	-2.255	-0.225	-0.065	-0.198	-0.119	-0.105	-0.162	-0.059
	(0.088)	(0.022)	(0.049)	(0.015)	(0.270)	(0.034)	(0.092)	(0.039)	(0.021)	(0.017)	(0.066)	(0.037)
Doc pr		-0.035		0.131								
		(0.015)		(0.015)								
Post-Doc												
Fac			0.303				0.082					0.013
			(0.067)				(0.067)					(0.010)

Table 3.A-15. Exogeneous Effects: Doctoral Segments, Faculty

	BIOL	CHEM	PHYS	GEOS	MATH	ECON	PSYC	CENG	CIVL	ELEC	MECH	CSCI
BachAll(000)		1.683	2.847		6.138	0.735	2.124		0.715	2.064		1.192
		(0.587)	(0.641)		(0.757)	(0.532)	(1.174)		(0.383)	(0.486)		(0.458)
Bach(0)	3.441	0.077	1.876	0.626	2.669	0.437	0.451	0.478	0.344	0.490	0.836	0.480
	(0.405)	(0.181)	(0.650)	(0.269)	(0.480)	(0.084)	(0.145)	(0.087)	(0.118)	(0.149)	(0.108)	(0.224)
Masters(0)	0.987		0.559			1.333	1.192	2.978	3.156	5.944	1.581	1.432
	(2.339)		(2.106)			(1.003)	(0.976)	(0.841)	(0.593)	(0.923)	(1.001)	(0.336)
Masters si											4.580	
											(1.984)	
Masters pr			0.764			0.387			-0.493			
			(1.426)			(0.745)			(0.311)			
R&D(000)	6.432	5.110	2.013	0.370	22.270	6.344	9.730	3.761	3.629	0.646	2.877	2.242
	(0.619)	(0.930)	(0.386)	(0.095)	(2.474)	(0.766)	(1.541)	(0.585)	(0.522)	(0.391)	(0.933)	(0.406)
R&D si							-97.955				-4.198	
							(21.002)				(1.893)	
R-Squared	87.9%	76.2%	77.6%	72.1%	80.0%	73.2%	58.9%	82.0%	81.3%	73.2%	77.1%	45.0%

Table 3.A-16. Exogeneous Effects: Doctoral Segments, Doctoral and PostDoctoral Students

	BIOL	CHEM	PHYS	GEOS	MATH	ECON	PSYC	CENG	CIVL	ELEC	MECH	CSCI
Doctoral												
BachAll(000)	20.063 (5.001)	13.316 (1.404)	9.098 (1.036)	12.110 (2.537)	11.827 (2.120)	13.435 (2.528)	14.333 (3.755)		8.481 (4.966)			9.374 (3.908)
BachAll si	247.962 (52.750)	27.750 (3.407)	31.868 (4.318)		148.563 (58.073)							
Bach(0)	12.187 (0.773)		6.273 (1.521)	8.492 (2.044)	4.716 (1.529)	0.883 (0.579)		3.669 (0.74)	2.466 (1.649)	7.854 (1.467)	3.968 (0.829)	6.322 (1.764)
Bach si	-43.999 (8.433)							-3.699 (2.398)			3.194 (2.671)	
R&D(000)	11.934 (0.956)	29.183 (2.228)	11.627 (0.833)	4.207 (0.646)	54.846 (5.697)	31.457 (5.430)	30.002 (6.163)	26.117 (4.037)	41.396 (14.963)	51.905 (9.290)	30.317 (5.703)	
R&D si	-5.843 (8.177)	-11.506 (4.452)	-9.320 (1.204)			-26.040 (18.008)	309.727 (98.538)	-30.477 (19.559)	-33.657 (34.232)	-72.093 (13.050)	-42.590 (11.879)	
R&D pr										35.729 (6.069)		
R-Squared	86.2%	87.8%	91.7%	69.1%	71.7%	74.5%	61.8%	68.6%	47.6%	63.0%	59.1%	48.0%
Post-Doctoral												
R&D(000)	7.093 (0.347)	9.190 (0.714)	2.308 (0.446)	0.487 (0.080)	1.930 (0.555)	0.539 (0.564)	0.884 (0.989)	1.144 (0.326)	1.013 (0.362)	0.272 (0.151)	0.184 (0.131)	
R&D si	3.433 (2.596)	1.609 (1.525)	-1.088 (0.563)	-0.381 (0.188)	11.829 (6.291)	1.744 (1.880)		6.775 (1.647)	-0.545 (0.870)	-0.085 (0.201)		
R-Squared	71.6%	83.5%	78.6%	45.6%	35.5%	9.5%	12.6%	41.4%	23.9%	25.6%	21.4%	19.6%

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Table 3.A-17. Utility and Exogeneous Effects: Private Liberal Arts Colleges

	BIOS	CHEM	PHYS	GEOS	MATH	ECON	PSYC	CENG	CIVL	ELEC	MECH	CSCI
u[y](000)	1.065	0.473	0.313	0.286	0.401	0.369	1.035	0.481	1.469	1.159	1.111	0.294
	(0.068)	(0.064)	(0.100)	(0.089)	(0.051)	(0.117)	(0.092)	(0.184)	(0.335)	(0.273)	(0.574)	(0.050)
BachAll(000)		9.427	8.354	6.222	10.763	10.053					0.386	2.919
		(0.450)	(0.417)	(0.479)	(0.509)	(0.730)					(1.023)	(0.338)
Bach(0)	1.132	1.311	2.073	1.299	1.755	0.797	1.232	1.256	1.660	1.387	0.931	1.200
	(0.044)	(0.080)	(0.212)	(0.135)	(0.126)	(0.045)	(0.061)	(0.152)	(0.081)	(0.132)	(0.192)	(0.143)
Masters(0)	1.390	3.854	7.585		2.689	3.675	1.336				0.549	
	(0.559)	(1.235)	(4.444)		(0.987)	(0.626)	(0.056)				(0.952)	
R&D(000)	27.150	14.182	17.208		96.072	7.953	44.983					
	(1.145)	(1.027)	(1.093)		(8.729)	(5.420)	(4.824)					
R-squared	75.7%	84.8%	78.8%	81.9%	81.7%	79.6%	75.3%	94.6%	95.6%	82.5%	80.4%	54.0%

Table 3.A-18. Utility and Exogeneous Effects: Private Comprehensive Institutions

	BIOS	CHEM	PHYS	GEOS	MATH	ECON	PSYC	CENG	CIVL	ELEC	MECH	CSCI
u[y](000)	0.412	0.149	0.056	0.311	-0.072	-0.458	-0.363	-0.285	0.788	0.033	0.127	0.188
	(0.250)	(0.221)	(0.136)	(0.089)	(0.188)	(0.352)	(0.279)	(0.596)	(0.538)	(0.855)	(1.411)	(0.170)
BachAll(000)	8.067	10.717	7.639	1.796	19.973	21.106	10.793	6.484	1.590	8.093	12.952	6.321
	(1.173)	(0.779)	(0.343)	(0.304)	(0.789)	(1.361)	(1.084)	(0.909)	(0.668)	(1.257)	(2.140)	(0.686)
Bach(0)	1.863	2.145	3.454	2.841	1.076		2.426	0.901	2.274	1.090	0.479	1.377
	(0.167)	(0.255)	(0.389)	(0.249)	(0.307)		(0.169)	(0.125)	(0.134)	(0.166)	(0.314)	(0.142)
Masters(0)	2.637		12.601	1.427		1.732	2.516					0.543
	(0.563)		(1.930)	(4.535)		(1.772)	(0.140)					(0.179)
R&D(000)	26.384	27.009	11.466	12.790	5.923		9.638	5.854		72.907	19.905	3.256
	(1.265)	(6.948)	(0.251)	(3.684)	(1.548)		(16.532)	(2.813)		(11.774)	(2.185)	(3.203)
R-squared	80.7%	70.2%	95.2%	79.6%	82.4%	56.6%	78.1%	95.7%	92.0%	89.5%	86.1%	77.6%

Table 3.A-19. Utility and Exogeneous Effects: Public Institutions

	BIOS	CHEM	PHYS	GEOS	MATH	ECON	PSYC	CENG	CIVL	ELEC	MECH	CSCI
u[y](000)	1.610 (0.423)	0.902 (0.253)	0.578 (0.207)	0.565 (0.234)	1.822 (0.382)	0.652 (0.308)	1.417 (0.401)	1.082 (0.681)	0.192 (0.795)	1.729 (0.642)	1.358 (0.610)	1.051 (0.244)
BachAll(000)	9.404 (0.785)	7.269 (0.335)	6.596 (0.238)	6.556 (0.349)	14.515 (0.650)	8.104 (0.430)	9.545 (0.707)	1.287 (0.363)	2.856 (0.657)	4.167 (0.553)	3.328 (0.424)	3.153 (0.291)
Bach(0)	1.335 (0.151)	3.005 (0.262)	1.077 (0.480)	1.529 (0.250)	1.862 (0.501)	1.215 (0.101)	1.530 (0.109)	1.044 (0.174)	3.291 (0.233)	1.364 (0.174)	1.395 (0.179)	1.212 (0.094)
Masters(0)	6.710 (0.747)	1.229 (1.128)		0.774 (0.885)	1.471 (1.192)	3.791 (1.285)	0.372 (0.201)	2.279 (1.609)			1.065 (2.061)	
R&D(000)	2.766 (1.098)	12.677 (1.690)	34.190 (1.441)	2.683 (0.109)	88.542 (14.489)	20.393 (3.705)	7.261 (4.316)	1.281 (4.343)		5.106 (5.240)	19.548 (4.380)	17.854 (7.281)
R-squared	81.8%	86.9%	86.1%	83.9%	78.8%	73.8%	86.1%	74.6%	77.8%	77.6%	82.1%	73.8%

Chapter 4
Estimating a Markov Model of Faculty Career Transitions

I. Introduction

As part of a larger project to simulate teaching and research in U.S. academic departments in science and engineering, we desired a model of faculty careers. Such a model is also useful for forecasting and budgeting at various levels of aggregation: university, state college system, or nationally.

Previous work on faculty careers has not analyzed transitions of individual faculty members over time. The most comprehensive survey of faculty is the National Survey of Postsecondary Faculty, which contained questionnaires for individual faculty and departments. The questionnaire for individual faculty members in 1987 asked faculty to identify their current rank, tenure status, and the year each was attained. From that, one can make some limited probability calculations, but the survey included only faculty currently employed in higher education institutions, not those who had changed jobs, retired, or died. As a result, the data does not account for all faculty career transitions. The NSOPF questionnaire for departments asked for the number of hires, departures, and tenure decisions during a single year (1986-87), but not by rank of faculty affected. From the departmental information, one year's transitions can be computed as an aggregate.

The work described in this paper uses data on individual faculty members in thirteen science and engineering fields, across a wide spectrum of institutions. Each faculty member is tracked over the period 1968-1992 through hiring, promotions, and departure. With this information, we compute transition probabilities from rank to rank and for departures from each rank.

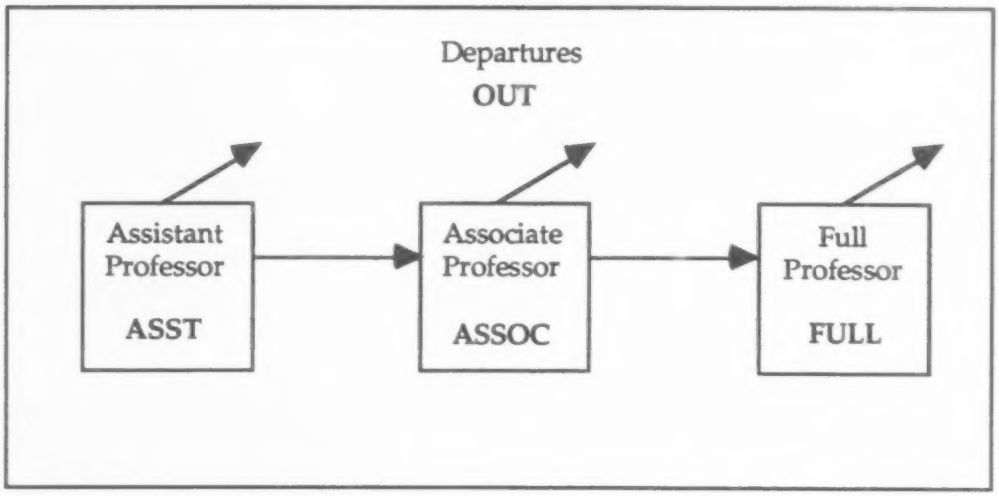
Using the data from different types of institutions over the 24-year period, we will test hypotheses about which factors related to institutions, disciplines, and time significantly affect the transition probabilities. The most interesting of the results concern the probability of promotion for an assistant professor, and the probability of departure for a full professor. These two transitions govern much of the flexibility that departments face in determining the size of their faculty under the tenure system.

II. Model

Figure 1 shows a Markov model of faculty careers from the perspective of an academic department. Careers cover the three rank stages: Assistant Professor, Associate Professor, and Full Professor. Faculty move from rank to rank or leave the department.

Figure 1

Faculty Transition Markov Model



We estimate a multinomial logit model corresponding to Figure 1, with fixed effects for

- institutional type and control (Carnegie class): Private Research University, Public Research University, Private Doctoral-Granting, Public Doctoral-Granting, Public Comprehensive, and Private Liberal Arts
- academic field: twelve fields listed in Table 1.1 (excluding Industrial Engineering)

For a complete reference on the multinomial logit, see Amemiya, page 295.

We tested several specifications for time, including separate fixed effects for each year in the sample and a linear time trend.

This allows us to test hypothesis related to questions such as:

- Does institutional type, academic field, or year significantly affect the probability of promotion for an assistant professor?
- Is the probability of departure for full professors affected by institutional type, academic field, or year?

III. Data

We solicited faculty rosters from 10 colleges and universities, spanning the range from liberal arts colleges to major research universities. We attempted to obtain rosters for the fields listed in Table 4.1, at three-year intervals from 1968 to 1992 (i.e., 1968, 71, 74, 77, 80, 83, 86, 89, and 92). Except for one of the public research universities, we were able to obtain data for the entire time period. Table 4.1 shows the distribution of institutions by type of control and Carnegie classification.

Table 4.1

Distribution of Schools

Carnegie type	Public	Private
RU	2	2
Doc	1	1
Comp	2	0
LAC	0	2

From the rosters supplied, we traced individual faculty members at the three-year intervals listed above through the academic ranks: Assistant, Associate and Full Professor. From the individual-level data, we computed the number of transitions along each arrow of Figure 4.1, for each three-year period, for each department in each school.

The aggregate transition frequencies (combining all fields, institutions, and three-year time periods) are reported in Table 4.2. The table shows the number of faculty moving "from" a given state (Out, Asst, Assoc, or Full), "to" a given state over a three-year period.

Table 4.2

Distribution of Transitions in the Data

		To				
		Out	Asst	Assoc	Full	Total
From	Out		460	216	255	931
	Asst	310	398	353	17	1078
	Assoc	176		468	369	1013
	Full	354			594	948
	Total	840	858	1037	1235	3970

Because faculty members are observed every three years, it is possible for our data to show a transition from Assistant to Full Professor over a three-year interval, skipping the Associate stage. Because the very few such observations did not allow for econometric precision, they are treated as transitions from Assistant to Associate in the estimations, with no material difference in the results. About five percent of all assistant professor promotions fell into this category.

IV. Estimation and Analysis

Estimations were performed using Stata 3.1 for three models: assistant, associate, and full. Figures 4.5-4.7 contain the results of the estimations, which are analyzed here. Despite testing several specifications for time effects, no significant effects were detected. Some of the tables report results from a model with a linear time trend in the underlying regressions, although the effects are insignificant. There may be time interaction effects with institutions, or specific fields, but this data set is not large enough to test for such effects.

The multiple equation models for assistant and associate professors are difficult to interpret directly, since changes in a parameter affect all the estimated equations. Therefore, this analysis relies on comparisons of the computed probabilities to illuminate the significance of the estimation

results. For reference, the results of the estimations are reproduced in Figures 4.5-4.7.

The results in Figures 4.2-4.3 present probabilities based on the estimated coefficients in Figure 4.5. Using the estimated coefficients of the model, we calculated the fraction of transitions that represent promotions (to Associate or Full Professor) as opposed to departures. A low percentage is consistent with tougher tenure standards. Figure 4.2 illustrates our results using coefficients for Biology over the period 1989-92. Other fields and time periods display the same pattern.

For assistant professors, the results of the estimation indicated that institutional type and control were significant. The estimated effects are consistent with the hypothesis that there are two promotion probabilites operating. The lower probability of promotion is associated with

- Private Research and
- Private Liberal Arts.

A higher probability of promotion is associated with

- Public Research,
- Private Doctoral-Granting,
- Public Doctoral-Granting, and
- Public Comprehensives.

To explore difference across fields, Figure 4.3 presents the same percentages for every field in Private Research Universities, 1989-92. Based on joint tests of equality of coefficients, differences in Figure 4.3 of about 20 percentage points or more are significant. For example, we cannot reject the hypothesis that math, economics, computer science, and physics are all governed by the same model. But this group of fields differs significantly from biology and chemistry.

For the Full Professor estimation, shown in Figure 4.7, the coefficients can be interpreted directly. A positive coefficient indicates that the effect makes full professors more likely to remain and less likely to leave. Figure 4.4 shows the computed probabilities for every field in Private Research Universities, 1989-92.

V. Converting to Annual Transition Probabilities

In order to use the models estimated here for an annual simulation of faculty transitions, one must convert the predicted transition probabilities, which represent three-year intervals. The calculation of this conversion is outlined below. Because our data are based on tracing a specific population of individuals over three-year intervals, we need not consider the continuing hiring of new members in the transition probabilities.

Consider a single state, with several possible transitions, for example, from ASST to ASST, ASSOC, or OUT. The estimation results in a predicted probability for each transition. For assistant professors, that is one transition remaining in the same state, ASST, and two transitions to other states. Let p_{OUT} represent the total annual probability of transitions out of the state to any other state and 1-p_{OUT} the annual probability of remaining in the state. $\hat{p}_{OUT}$ is our calculated three-year probability of transitions out of the state. $\hat{p}_{OUT}$ satisfies the equation:

$$\hat{p}_{OUT} = p_{OUT}\left(1+(1-p_{OUT})+(1-p_{OUT})^2\right) \tag{4.1}$$

This equation has a single real solution:

$$p_{OUT} = 1-(1-\hat{p}_{OUT})^{\frac{1}{3}} \tag{4.2}$$

If p_1 is the probability of a transition out of the state, to a single new state, such as ASST to ASSOC, then the three-year probability, $\hat{p}_1$, must obey

$$\hat{p}_1 = p_1\left(1+(1-p_{OUT})+(1-p_{OUT})^2\right). \tag{4.3}$$

Using the equations (4.1) and (4.3), we derive the relation for any transition probability,

$$p_1 = \hat{p}_1\left(\frac{p_{OUT}}{\hat{p}_{OUT}}\right). \tag{4.4}$$

Figure 4.2

Assistant Professors
Estimated Promotions as Fraction of Transitions

(Biology, 1968-71 and 1989-92)

	1968-	1989-
Private Research	47.0%	54.5%
Public Research	66.1%	72.5%
Private Doctoral-	68.0%	74.1%
Public Doctoral-	68.6%	74.7%
Public Comprehensives	65.1%	71.6%
Private Liberal Arts	48.8%	56.3%

Figure 4.3

Assistant Professors
Estimated Promotions as Fraction of Transitions

(Private Research Universities, 1968-71 and 1989-92)

Field	1968-71	1989-92
math*	22.7%	28.4%
econ*	27.3%	33.7%
csci*	28.5%	35.0%
phys*	34.5%	41.6%
mech	35.1%	42.2%
psyc	39.8%	47.2%
chem	42.7%	50.2%
biol	47.0%	54.5%
civl	47.4%	54.9%
ceng	55.3%	62.6%
geos	56.2%	63.5%
elec	63.5%	70.2%
indu	68.7%	74.8%

*Denotes effects significant at the 5% level (asymptotic), from logit with Biology as comparison field, with linear term for time.

Figure 4.4

Full Professors
Estimated Transitions

(Private Research Universities, 1989-92)

Field	Percent Remaining	Percent Leaving
indu	83.1%	16.9%
geos	84.5%	15.5%
biol	84.8%	15.2%
psyc	85.4%	14.6%
civl	85.6%	14.4%
math	87.9%	12.1%
chem	87.9%	12.1%
phys*	89.3%	10.7%
csci*	90.0%	10.0%
econ*	90.1%	9.9%
ceng	91.9%	8.1%
elec*	92.1%	7.9%
mech*	93.1%	6.9%

*Denotes effects significant at the 5% level (asymptotic), from Logit with Biology as comparison field, with linear term for time.

Figure 4.5

Assistant Professors
Multinomial Logit Estimation

Assistant professors can move to four states in the Markov chain: ASST, ASSOC, or OUT. The model is estimated with a two-equation multinomial logit, with OUT as the comparison state. This model does not include a time specification.

Multinomial regression — Number of obs = 2235
chi2(34) = 228.26
Prob > chi2 = 0.0000
Log Likelihood = -2341.2677 — Pseudo R2 = 0.0465

to	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
Asst |						
ceng	.5627646	.4585652	1.227	0.220	-.3360067	1.461536
chem	.1508537	.2208513	0.683	0.495	-.2820069	.5837142
civl	-.026504	.3197876	-0.083	0.934	-.6532763	.6002682
csci	-.2307624	.2186633	-1.055	0.291	-.6593345	.1978098
econ	-.3846522	.2123296	-1.812	0.070	-.8008106	.0315062
elec	.4592773	.3463532	1.326	0.185	-.2195626	1.138117
geos	.2027562	.3241364	0.626	0.532	-.4325394	.8380518
indu	.8083618	.6731146	1.201	0.230	-.5109187	2.127642
math	-.6927213	.1993553	-3.475	0.001	-1.083451	-.301992
mech	-.5341861	.3783065	-1.412	0.158	-1.275653	.2072811
phys	-.5212738	.2171377	-2.401	0.016	-.9468559	-.0956917
psyc	-.3289815	.2273485	-1.447	0.148	-.7745763	.1166132
priru	.4909212	.1698261	2.891	0.004	.1580682	.8237742
pubru	.7749229	.1837898	4.216	0.000	.4147015	1.135144
pridoc	1.491562	.2582117	5.777	0.000	.985476	1.997647
pubdoc	.7192623	.2110637	3.408	0.001	.3055852	1.13294
comp	.5377151	.1811287	2.969	0.003	.1827093	.8927208
lac	.3955395	.2722647	1.453	0.146	-.1380895	.9291685

Assoc						
ceng	.3254119	.4767167	0.683	0.495	-.6089356	1.259759
chem	-.1545603	.2317916	-0.667	0.505	-.6088635	.299743
civl	.092971	.3251063	0.286	0.775	-.5442256	.7301676
csci	-.7576423	.2362935	-3.206	0.001	-1.220769	-.2945156
econ	-.8444797	.2335934	-3.615	0.000	-1.302314	-.3866449
elec	.65551	.3473838	1.887	0.059	-.0253498	1.33637
geos	.3722703	.3280099	1.135	0.256	-.2706174	1.015158
indu	.9704187	.70057	1.385	0.166	-.4026733	2.343511
math	-1.127718	.2201613	-5.122	0.000	-1.559226	-.6962094
mech	-.4714517	.3822822	-1.233	0.217	-1.220711	.2778076
phys	-.5076097	.2237248	-2.269	0.023	-.9461023	-.0691172
psyc	-.3134152	.2339853	-1.339	0.180	-.772018	.1451876
priru	.0104106	.1801806	0.058	0.954	-.3427369	.363558
pubru	.8117018	.1873737	4.332	0.000	.444456	1.178948
pridoc	.9706447	.2843611	3.413	0.001	.4133072	1.527982
pubdoc	.8838969	.2135964	4.138	0.000	.4652556	1.302538
comp	.7216118	.1821493	3.962	0.000	.3646056	1.078618
lac	.1386887	.2992495	0.463	0.643	-.4478296	.7252069

(Outcome to==Out is the comparison group)

The omitted field is Biology.

Figure 4.6

Associate Professors
Multinomial Logit Estimation

Associate professors can move to three states in the Markov chain: ASSOC, FULL, or OUT. The model is estimated with a two-equation multinomial logit, with OUT as the comparison state. This model does not include a time specification.

Multinomial regression — Number of obs = 2261
chi2(34) = 801.68
Prob > chi2 = 0.0000
Log Likelihood = -2083.1239 — Pseudo R2 = 0.1614

to	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
Assoc						
ceng	.8454932	.7628156	1.108	0.268	-.6495979	2.340584
chem	.1783011	.3195488	0.558	0.577	-.448003	.8046052
civl	-.1041054	.3618413	-0.288	0.774	-.8133013	.6050904
csci	-.2228237	.2918466	-0.763	0.445	-.7948325	.3491851
econ	-.2962385	.294549	-1.006	0.315	-.8735439	.281067
elec	.3308128	.3634255	0.910	0.363	-.3814881	1.043114
geos	.2360339	.3900393	0.605	0.545	-.5284291	1.000497
indu	-1.234996	.5890387	-2.097	0.036	-2.38949	-.080501
math	.0667905	.2872444	0.233	0.816	-.4961981	.6297792
mech	.3300175	.3894114	0.847	0.397	-.4332149	1.09325
phys	.0983877	.3004118	0.328	0.743	-.4904086	.6871841
psyc	-.1724955	.2710432	-0.636	0.525	-.7037303	.3587394
priru	1.522678	.2351593	6.475	0.000	1.061774	1.983581
pubru	1.610641	.2160936	7.453	0.000	1.187105	2.034176
pridoc	1.915437	.3408932	5.619	0.000	1.247298	2.583575
pubdoc	2.094287	.3114396	6.725	0.000	1.483877	2.704697
comp	1.676695	.220193	7.615	0.000	1.245124	2.108265
lac	1.634689	.4485026	3.645	0.000	.7556403	2.513738

Full						
ceng	.9110022	.7748332	1.176	0.240	-.6076429	2.429647
chem	.2727527	.3288552	0.829	0.407	-.3717917	.9172971
civl	.177209	.3681656	0.481	0.630	-.5443823	.8988004
csci	-.4026932	.3108795	-1.295	0.195	-1.012006	.2066194
econ	-.1833948	.305523	-0.600	0.548	-.7822088	.4154193
elec	.3181965	.3753153	0.848	0.397	-.417408	1.053801
geos	.2962168	.3993042	0.742	0.458	-.486405	1.078839
indu	-1.344779	.6261377	-2.148	0.032	-2.571986	-.1175711
math	-.2538435	.3042864	-0.834	0.404	-.850234	.3425469
mech	.1112926	.4080146	0.273	0.785	-.6884013	.9109866
phys	.0301753	.3113795	0.097	0.923	-.5801173	.6404679
psyc	-.3498258	.2856226	-1.225	0.221	-.9096358	.2099842
priru	1.344779	.2423121	5.550	0.000	.8698555	1.819701
pubru	1.199215	.2249597	5.331	0.000	.7583025	1.640128
pridoc	1.229072	.3627228	3.388	0.001	.5181478	1.939995
pubdoc	2.01353	.3164848	6.362	0.000	1.393231	2.633829
comp	1.108641	.2309335	4.801	0.000	.6560192	1.561262
lac	.8831661	.487384	1.812	0.070	-.072089	1.838421

(Outcome to==Out is the comparison group)

The omitted field is Biology.

Figure 4.7

Full Professors
Logit Estimation

Full professors can either remain full professors or leave. With only two states, the estimation is done with ordinary logit, giving coefficients for the probability of remaining (REMAIN). This model does not include a time specification.

Logit Estimates — Number of obs = 6895

Log Likelihood = -2711.2252

Remain	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
ceng	.5392347	.2925239	1.843	0.065	-.0341017	1.112571
chem	.1574035	.1479993	1.064	0.288	-.1326699	.4474768
civl	-.0643671	.162293	-0.397	0.692	-.3824554	.2537213
csci	.1149424	.1622283	0.709	0.479	-.2030192	.432904
econ	.326391	.1613073	2.023	0.043	.0102345	.6425475
elec	.1726791	.1582487	1.091	0.275	-.1374826	.4828408
geos	.0240284	.1789799	0.134	0.893	-.3267657	.3748225
indu	-.2323221	.503921	-0.461	0.645	-1.219989	.7553449
math	.5190809	.1614376	3.215	0.001	.202669	.8354927
mech	.2651454	.1918216	1.382	0.167	-.1108179	.6411087
phys	.3254856	.1458004	2.232	0.026	.0397221	.611249
psyc	.0418983	.1421021	0.295	0.768	-.2366168	.3204134
priru	1.84176	.1180525	15.601	0.000	1.610381	2.073139
pubru	1.476892	.1123889	13.141	0.000	1.256614	1.69717
pridoc	1.534427	.2607648	5.884	0.000	1.023338	2.045517
pubdoc	2.177538	.1644128	13.244	0.000	1.855294	2.499781
comp	1.701995	.1216418	13.992	0.000	1.463582	1.940409
lac	1.050764	.2761045	3.806	0.000	.5096091	1.591919

The omitted field is Biology.

References

Amemiya, Takeshi [1985]. *Advanced Econometrics*, Harvard University Press, Cambridge, Massachusetts.

Russell, Susan H., *et. al.* [1990]. *1988 National Survey of Postsecondary Faculty (NSOPF-88) A Descriptive Report of Academic Departments in Higher Education Institutions*, NCES 90-339, U.S. Department of Education, Office of Educational Research and Improvement, National Center for Education Statistics.

Russell, Susan H., et. al. [1991]. *1988 National Survey of Postsecondary Faculty (NSOPF-88) Profiles of Faculty in Higher Education Institutions, 1988*, NCES 91-389, U.S. Department of Education, Office of Educational Research and Improvement, National Center for Education Statistics.

Stata Corporation [1993].*Stata, Release 3.1*, College Station Texas.

Stata Corporation [1993]. *Stata Reference Manual: Release 3.1*, 6th ed., College Station Texas.

Chapter 5
Segmentation

We have used institutional groupings, called "segments," throughout this report. Modeling every doctorate-granting university in a given field is impractical, yet the simulation requires a degree of institutional heterogeneity in order to deal with personnel shifts among institutions. This chapter describes the method we used to divide our universe of institutions into a separate set of segments for each of the thirteen science and engineering fields included in our study. Each field also contains three additional segments, which represent institutions that do not grant the doctorate. They are private liberal arts colleges, private comprehensive universities, and public colleges and comprehensive universities. The definitions for the non-doctoral segments are determined by the Carnegie classification system; hence the statistical procedures described in sections 5.1 through 5.3 do not apply.

I. Variables

Data were obtained from NSF's CASPAR data system for 1980, the only year for which faculty are available by field and institution. In addition to the number of faculty (NFAC), the following variables used in the segmentation analysis:

R&D: sponsored R&D dollars in thousands	Expenditure on research equipment
Full-time science & engineering personnel	Total graduate students in science & engrg.
Full-time science & engineering personnel	Part-time grad. students in science & engrg.
Science & engineering post-doctoral fellows	Masters degrees granted
Total doctoral degrees granted (survey I)	Total doctoral degrees granted (survey II)
Doctoral degrees granted to U. S. citizens	Bachelors degrees granted (whole institution)
Doctoral degrees granted to foreigners	Bachelors degrees granted (majors)

The definitions are self-evident, except for the two surveys of doctoral degrees granted. Survey I comes from the "NSF Doctorate Survey File—Doctorate Institution Counts, Total Number of Doctorate Degrees." This variable is labeled "Tot Doc Deg" in the tables. The figures for doctorates granted to U.S. citizens and foreigners ("U.S. Doc Deg" and "TR Doc Deg") come from the same source. Survey II ("Degs Doc") comes from the file for "NCES Earned Degrees, Degrees Awarded. "Degs All" refers to "Bachelors degrees granted (whole

institution)", "Degs Bach" to "Bachelors degrees granted (major)", and "Degs M" refers to "Masters degrees granted."

II. Procedure

The segmentation procedure involves five steps: (1) estimate missing values for *NFac* and *R&D;* (2) perform factor analysis using the missing-data estimates where needed; (3) calculate factor scores for the first factor; (4) sort the institutions by their factor scores; and (5) allocate institutions into segments with roughly equal number of doctoral students. Steps (1)-(3) are performed without regard to type of institutional control. Steps (4) and (5) are performed separately for the public and public institutions. Step (5), the final allocation, takes account where possible of natural breaking points in the distribution of factor scores—for example, we tried not to break in the middle of a clump of institutions whose scores differ by only a small amount.

We wish to establish each segment in a way such that student-faculty and similar "productivity" ratios will be relatively homogeneous within segments and heterogeneous among them. Therefore, we divide the variables by the number of faculty (*NFac*) before factor analysis. Thus, adjacent points on the real line defined by the first factor will represent institutions with what we might call "similar production processes." Without the transformation, the first factor would simply represent institutional size. By including a disproportionate number of variables related to graduate education and research, we increase the likelihood that the first factor will represent that set of activities. Indeed, one can view the factor analysis simply as a method for translating our battery of research and graduate education variables into a single interval-scaled dimension.

The sub-model for predicting missing faculty and research-spending values is motivated by the fact that the NSF survey data for these variables are not as complete as the remainder of the data described above or the data used elsewhere in our modeling. To exclude an institution from the segmentation analysis means that none of the other data for that school could be used in any model. This would have been an unfortunate loss. Since factor analysis and subsequent partitioning introduces an element of error in any case, we felt that little would be lost and much would be gained by plugging the missing-data holes with least-squares predictions.

NFac is predicted by *FT S&E.adj and FT S&E.adj,* while *R&D* is predicted by the value of *NFac* after adjustment for the missing data predictions. The regressions include only those institutions with positive values for the dependent

variable (denoted by *NFac.GT0* and *R&D.GT0* in the results tables). The prediction equation for *R&D* is linear through the origin, which can be estimated by ordinary least squares with constant suppressed. However, the equation for *NFac* is more complicated:

$$NFac = b_{FT\,S\&E} \log\left[\frac{FT\,S\&E}{b_{FT\,S\&E}} + 1\right] + b_{PT\,S\&E} \log\left[\frac{PT\,S\&E}{b_{PT\,S\&E}} + 1\right] \tag{5.1}$$

where the quantities within the braces are called *FT S&E.adj* and *PT S&E.adj*, respectively. Estimation proceeds by choosing trial values for the coefficients, calculating new values by ordinary least squares through the origin, and iterating until convergence. The transformation drives the curve through the origin and sets its partial derivatives with respect to each independent variable equal to one at the origin. The latter condition is motivated by the observation that the first full or part-time S&E professional in a department is likely to be a faculty member.

III. Results

Missing-Data Regressions

Tables 5.1 reports least squares results for the estimation of missing values for *NFac* and *R&D*. The results appear quite satisfactory. For example, the Physics faculty (*nFac*) coefficient for full-time science and engineering personnel (*FT S&E*) is ten times its standard error, and the figure for part-time personnel (*PT S&E*) is more than twice its standard error. For R&D, the *nFac* figure is both positive, though not significant, and the one for postDocs is highly significant. This is essentially a reduced-form equation, so we worry more about predictive power than structural integrity. Our regression package does not calculate R-squares for regressions through the origin, but the scatter diagrams presented in Figures 5.1 and 5.2, coupled with the significance of the coefficients, give us the assurance we wanted. The residuals form a fan-shaped pattern, as would be expected in a regression with natural origin at zero, and there are few outliers.

Figure 5.1
Scatter Diagram of Predicted F
Versus the Regression Residual

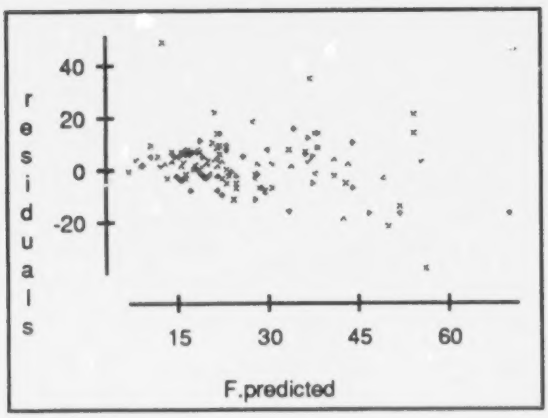
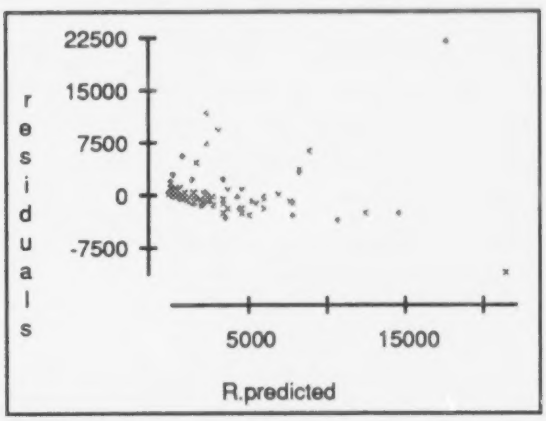


Figure 5.2
Scatter Diagram of Predicted R
Versus the Regression Residual



We observed similar patterns for the other fields. The coefficients in Table 5.1 are all positive, and most of them are statistically significant. The actual and predicted values of *NFac* and *R&D* for each institution and field are given in Appendix Tables 5-A1 through 5-A12, along other statistical information and the assignments of institutions to segments.

Table 5.1

Missing-Value Regression Results

(the standard errors of the coefficients are in parentheses)

	PHYS	BIOS	CHEM	GEOS	MATH	ECON	PSYC	CENG	CIVL	ELEC	MECH	CSCI
N Fac												
FT S&E	21.84	70.45	17.92	9.80	52.02	18.44	37.03	17.79	25.90	17.66	16.77	13.95
	(1.23)	(5.74)	(0.72)	(1.10)	(4.28)	(1.58)	(4.08)	(1.52)	(2.32)	(1.64)	(1.46)	(1.96)
PT S&E	7.41	40.95	4.20	2.06	5.38	1.81	2.00	1.01	1.25	24.41	22.63	2.07
	(2.61)	(14.96)	(0.87)	(1.32)	(2.94)	(1.21)	(1.90)	(.78)	(1.17)	(6.40)	(6.24)	(2.02)
R&D												
N Fac	7.59	22.83	21.31	77.05	7.64	28.14	18.50	51.10	40.35	54.60	46.63	63.88
	(11.31)	(4.14)	(3.04)	(29.52)	(0.92)	(2.53)	(2.03)	(4.47)	(4.82)	(10.16)	(8.10)	(9.38)
Postdocs	211.39	87.17	55.77	825.57	78.73	11.35	69.24	38.00	80.60	392.45	190.82	50.81
	(17.95)	(6.09)	(3.07)	(119.4)	(11.06)	(11.00)	(13.15)	(15.67)	(35.19)	(114.9)	(74.65)	(144.5)

Factor Analysis

Table 5.2 presents the factor analysis results for the twelve fields. For Physics, the first factor accounts for 47% of the variance. (The second is far behind at 11.7%, a pattern that is replicated for the other fields.) The first factor loads most heavily on *TotDocDegree* with most of the other variables also loading heavily. (The loading pattern's sign is arbitrary: that is, multiplying all the loadings by –1 would not change the structure.) Only the two part-time variables and *DegsBach* have loadings of less than 0.5. It appears, then that the first factor picks up the general weight of effort in graduate education and research, per faculty member, as intended.

The patterns for the other fields are generally similar, except for the occasional meaningless sign reflection. The explained-variance percentages generally lie in the 30 to 40 percent range, somewhat lower than for Physics but still respectable. The loadings on doctoral enrollment per faculty member and doctoral degrees per faculty member are among the largest for every field. This supports the idea of using the faculty scores to segment institutions according to the intensity of their doctorate-production activities.

Segments

Table 5.3 provides, for each field, summary statistics on the assignment of institutions to segments and the segment characteristics. Segments 1 through 4 group the private doctoral-granting institution, and segments 5 through 10 group their public counterparts. Blanks indicate that the field did not receive the full complement of segments, either because it contains too few institutions or because the factor-score distribution did not offer enough natural stopping points. Segments 11 through 13 group the non-doctorate institutions. Segment 11 represents the private liberal arts colleges, segment represents 12 the private comprehensives, and segment 13 represents all the public non-doctorates.

For each doctoral segment we provide, first, the number of institutions assigned to the segment. (The names of the institutions are provided in the Appendix.) Next we provide the mean factor score for the segment ("S-index"). Notice that the scores decrease monotonically within the public and private groupings. Large positive scores for segment 1 indicate a concentration of institutions at the top of the factor-score distribution. (The largest single score equals one in all cases.) Since the factor-score mean equals zero, at least one segment must have a negative score. The largest institutional counts appear in the last public and private segments, which represent "catch-all" groupings.

Table 5.2
Factor Loadings

	PHYS	BIOS	CHEM	GEOS	MATH	ECON	PSYC	CENG	CIVL	ELEC	MECH	CSCI
R&D	-0.735	-0.647	0.856	-0.674	-0.872	-0.464	0.052	-0.379	-0.377	-0.489	-0.380	0.671
FT S&E	-0.559	-0.804	0.637	-0.768	-0.778	-0.551	0.477	-0.367	-0.392	-0.251	-0.276	0.413
PT S&E	-0.233	-0.545	0.331	-0.416	-0.845	-0.118	0.686	-0.223	-0.289	-0.208	-0.193	0.044
S&E PostDocs	-0.784	-0.534	0.836	-0.631	-0.142	-0.282	0.297	-0.572	-0.286	-0.411	-0.469	0.449
Tot Doc Deg	-0.913	-0.665	0.913	-0.901	-0.671	-0.913	0.874	-0.896	-0.738	-0.880	-0.860	0.713
US Doc Deg	-0.870	-0.655	0.892	-0.888	-0.722	-0.879	0.859	-0.748	-0.642	-0.799	-0.765	0.629
TR Doc Deg	-0.558	-0.153	0.407	-0.331	-0.150	-0.757	0.113	-0.736	-0.542	-0.631	-0.647	0.638
Res Equip	-0.615	-0.634	0.633	-0.710	-0.481	-0.115	0.015	-0.379	-0.327	-0.303	-0.297	0.583
Tot Gr S&ES	-0.875	-0.869	0.867	-0.457	-0.860	-0.750	0.866	-0.821	-0.629	-0.793	-0.765	0.602
PT Gr S&ES	-0.033	-0.307	-0.110	-0.132	-0.903	-0.316	0.419	-0.352	-0.448	-0.399	-0.344	0.360
Degs All	-0.796	-0.682	0.406	-0.547	-0.915	-0.673	0.350	-0.706	-0.724	-0.769	-0.691	0.379
Degs Doc	-0.866	-0.426	0.923	-0.891	-0.666	-0.910	0.736	-0.829	-0.724	-0.875	-0.836	0.777
Degs M	-0.623	-0.510	0.393	-0.533	-0.923	-0.709	0.581	-0.702	-0.724	-0.821	-0.688	0.502
Degs Bach	-0.491	-0.629	0.115	-0.314	-0.592	-0.534	0.156	-0.573	-0.497	-0.573	-0.552	0.155
% variance	47.0	36.5	43.5	39.5	56.0	39.5	30.4	39.3	30.3	39.8	35.5	28.5

Table 5.3
Number of Institutions, S-index, and Cost Coefficients, By Segment

Seg	Variable	PHYS	BIOS	CHEM	GEOS	MATH	ECON	PSYC	CENG	CIVL	ELEC	MECH	CSCI
Doctoral Segments													
1	N	3.	14.	8.	7.	8.	6.	7.	10.	11.	4.	9.	7.
	S-index	0.799	0.180	0.694	0.224	0.116	0.500	0.362	0.402	0.403	0.917	0.515	0.607
	Cost[Doc]	8.9	7.3	7.8	7.8	7.6	9.0	6.9	10.3	10.6	9.5	10.6	9.1
	Cost[Fac]	46.3	31.5	37.4	34.4	32.7	37.7	28.7	45.1	46.7	42.1	46.4	34.7
	Cost[PD]	17.8	14.6	15.5	15.7	15.3	18.0	13.7	20.7	21.3	19.0	21.2	18.2
2	N	6.	25.	10.	4.	8.	7.	13.	66.	65.	4.	67.	69.
	S-index	0.408	-0.004	0.304	0.082	0.059	0.237	0.092	-0.069	-0.034	0.645	-0.030	-0.024
	Cost[Doc]	8.5	6.9	7.5	8.0	7.1	8.9	7.1	9.5	9.5	11.6	9.5	8.0
	Cost[Fac]	40.5	29.5	33.9	34.8	30.1	37.6	29.2	40.5	40.4	51.2	40.1	29.9
	Cost[PD]	17.0	13.8	15.0	16.0	14.2	17.8	14.2	19.1	19.0	23.2	19.1	16.0
3	N	9.	37.	58.	65.	9.	10.	14.			8.		
	S-index	0.207	-0.085	-0.095	-0.085	0.024	0.134	0.030			0.320		
	Cost[Doc]	7.2	6.8	6.9	7.2	7.6	8.4	6.8			9.8		
	Cost[Fac]	34.2	28.3	28.9	29.3	32.5	34.8	29.0			42.5		
	Cost[PD]	14.4	13.7	13.8	14.5	15.2	16.8	13.7			19.6		
4	N	58.	22.	4.	4.	51.	53.	42.			60.		
	S-index	-0.048	0.138	0.642	0.909	-0.020	-0.070	-0.050			-0.081		
	Cost[Doc]	7.5	6.9	7.3	7.3	7.2	8.4	7.0			9.5		
	Cost[Fac]	32.3	27.5	33.5	30.1	28.0	32.9	29.4			39.9		
	Cost[PD]	15.0	13.8	14.6	14.7	14.4	16.9	13.9			19.0		
5	N	5.	11.	6.	6.	6.	4.	12.	7.	8.	4.	4.	14.
	S-index	0.462	0.057	0.442	0.438	0.080	0.546	0.081	0.519	0.536	0.669	0.671	0.279
	Cost[Doc]	7.9	7.0	6.4	7.2	7.5	8.5	6.5	8.4	9.1	9.5	9.0	8.4
	Cost[Fac]	34.6	28.7	28.3	29.4	30.0	34.0	27.0	32.4	35.6	39.5	37.4	31.6
	Cost[PD]	15.9	13.9	12.8	14.4	15.0	16.9	13.1	16.9	18.1	19.0	18.0	16.8
6	N	4.	16.	9.	6.	15.	6.	12.	6.	11.	7.	4.	119.
	S-index	0.335	0.014	0.315	0.316	0.032	0.382	0.034	0.365	0.242	0.378	0.403	-0.040
	Cost[Doc]	7.6	6.7	7.1	6.9	6.9	8.1	6.7	9.0	8.8	7.9	9.3	8.5
	Cost[Fac]	35.0	27.4	30.8	28.6	27.1	31.6	27.8	35.7	34.9	31.6	36.4	29.5
	Cost[PD]	15.3	13.4	14.2	13.7	13.8	16.2	13.4	18.0	17.6	15.8	18.6	16.9

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Table 5.3
Number of Institutions, S-index, and Cost Coefficients, By Segment (continued)

Seg	Variable	PHYS	BIOS	CHEM	GEOS	MATH	ECON	PSYC	CENG	CIVL	ELEC	MECH	CSCI
Doctoral Segments													
7	N	6.	11.	10.	6.	12.	8.	13.	8.	9.	5.	10.	
	S-index	0.239	-0.020	0.160	0.205	0.012	0.223	0.013	0.162	0.149	0.247	0.292	
	Cost[Doc]	7.4	7.2	7.0	7.1	6.8	7.8	6.7	8.7	8.7	9.0	8.9	
	Cost[Fac]	32.1	29.5	30.2	29.0	27.1	29.9	28.0	35.4	33.4	34.3	34.9	
	Cost[PD]	14.7	14.5	14.1	14.2	13.6	15.7	13.3	17.4	17.5	18.0	17.8	
8	N	14.	12.	15.	9.	9.	12.	16.	112.	105.	12.	23.	
	S-index	0.158	-0.041	0.076	0.126	0.002	0.154	-0.005	-0.102	-0.100	0.134	0.067	
	Cost[Doc]	7.3	7.1	6.9	7.2	6.8	7.9	6.6	8.7	8.7	8.6	8.9	
	Cost[Fac]	32.0	29.7	30.0	28.3	27.2	31.1	26.8	33.7	33.2	33.8	34.4	
	Cost[PD]	14.7	14.2	13.9	14.4	13.6	15.9	13.2	17.4	17.4	17.1	17.7	
9	N	17.	18.	22.	18.	22.	18.	21.			17.	92.	
	S-index	0.026	-0.060	-0.020	0.045	-0.011	0.054	-0.022			0.008	-0.131	
	Cost[Doc]	7.2	6.9	7.2	7.0	7.1	8.2	6.6			9.1	8.7	
	Cost[Fac]	30.4	28.0	30.4	27.2	27.9	31.6	27.3			34.8	32.7	
	Cost[PD]	14.4	13.8	14.5	14.1	14.3	16.4	13.1			18.1	17.3	
10	N	87.	43.	67.	84.	69.	85.	59.			88.		
	S-index	-0.106	-0.096	-0.171	-0.092	-0.033	-0.102	-0.064			-0.173		
	Cost[Doc]	7.1	6.8	6.5	6.7	6.8	7.8	6.6			8.8		
	Cost[Fac]	29.0	27.1	27.0	25.2	25.9	28.5	26.9			33.2		
	Cost[PD]	14.3	13.7	13.1	13.3	13.5	15.7	13.2			17.5		
Non-Doctoral Segments													
11	N	358.	461.	451.	142.	448.	365.	414.	8.	23.	23.	87.	201.
	Cost[Fac]	22.6	19.5	20.5	19.6	19.5	22.6	19.4	26.7	26.7	26.7	26.7	19.9
12	N	207.	235.	230.	86.	234.	205.	221.	15.	33.	49.	358.	139.
	Cost[Fac]	24.4	21.0	22.0	21.1	20.9	24.3	20.9	28.8	28.8	28.8	28.8	21.4
13	N	304.	315.	315.	240.	313.	290.	295.	33.	83.	89.	87.	240.
	Cost[Fac]	26.4	24.4	25.0	23.2	23.5	26.0	23.8	29.5	29.5	29.5	29.5	25.9

The last three figures represent the unit per-annum cost of doctoral students, faculty, and postdocs as used in the departmental utilization model. The figures are in 1980 dollars. Their derivation, described in Chapter 3, builds upon institution and field specific factors. In the case of faculty, the figures also reflect differences in faculty rank distributions among institutions. Scanning the faculty numbers, we see the expected pattern of differences by field: for example, engineering and physics pay more than the other fields, and biology and psychology tend to be at the bottom of the pay scale.

Within each type-of-control group, institutions with high factor scores appear to pay more than those with lower scores. Holding score constant, private institutions appear to pay more than public ones. A relationship between the segment index and faculty compensation would support our belief that schools with high factor scores tend to be more elite. To test the hypothesis, we regressed cost[*Fac*] on a normalized version of the segment index ("*S-indexN*") and type of control (*toc*). The normalization scales each field's top segment index to one and bottom segment to zero, thus removing the effect of field from the regression. The values of toc are as in Chapter 3: *toc*=1 for the private segments and *toc*=0 for the public ones.

(5.2) $$\text{cost}[Fac] = \underset{(0.73)}{29.35} + \underset{(0.92)}{3.91}\ S\text{-}indexN + \underset{(1.26)}{3.96}\ toc, \qquad R^2 = 0.25$$

The regression supports our hypothesis. *S-index*'s coefficient is positive and highly significant (t=4), even when *toc* is taken into account. The degree of fit is only 25%, but this is highly significant with 100 degrees of freedom. Moving from the lowest to the highest segment adds almost four thousand dollars, about 13 percent, to faculty compensation. Moving from a public to a private institution with a similar segment score adds another 13 percent. Since faculty compensation tends to vary with faculty quality, which in turn varies with prestige, we feel justified in associating higher factor scores with higher prestige. (The fraction of research universities in the segment also supports this proposition.) Prestige is not a crucial issue for our research, but it does aid interpretation—which is why we have spoken of "elite" and "non-elite" segments from time to time.

Appendix Tables 5-A.1 through 5-A.12 present the universe of institutions, their actual and predicted values of NFac and R&D, and their scores on the first factor. The table is arrayed by rank-order of normalized factor score, first for private institutions and then for public ones. (These are the raw factor scores, which have not yet been normalized to make the top institution's score equal to plus one.) The tables also contain the fraction of institutions in the segment as

Carnegie "research universities" ("segment RU fraction"), the total number of faculty represented by the segment ("segment faculty"), and, as noted earlier, the raw and adjusted values for *NFac* and *R&D*. The RU fraction provides a measure of the academic prestige associated with the segment. The figure tends to decline as one moves down the segment hierarchy, as we anticipated.

As might be expected, the more prestigious schools tend to come out at the top of the private-sector table: for example, in the case of Physics, Harvard, MIT, Cal. Tech, Cornell, and Stanford comprise segment 1. The array seems somewhat more mixed in the case of the public sector, with places like Oregon and SUNY-Albany ranking ahead of Berkeley. This should not be surprising given the relatively low R-squared in equation (5.2).

Scanning through the other Appendix tables confirms the incidence of more-prestigious institutions in the segments with larger factor scores. Yet there are frequent anomalies, or at least what appear to be anomalies. Should Clark Atlanta University really be in the top segment for Biological Sciences, for example? This historically-black university has climbed recently in the sponsored research standings, but the segmentation-analysis data were collected in 1980. Could it be that the data show something real, but not contemporaneously recognized, about Clark Atlanta's doctoral-program intensity? Or is the result just a statistical anomaly?

While we cannot separate the surprising from the anomalous, we are confident that, across the population of institutions, the factor analysis captures some meaningful relationships. The correlations reported above and the significance of the segmentation production-function coefficients, reported in Chapter 3, support this conclusion.

Table 5-A.1: Segmentation Array: Physics

School	FICE	TOC	Carnegie Class	Academic Discipline	Faculty	Faculty (adjusted)	R&D Expenditures	R&D Exp (adjusted)	Factor Score	Segment	Segment RU Fraction	Segment Faculty
Harvard University	2155	Pri	R1	Phys&Astr	28	28.00	6,894	6,894	-4.90	PHYS01	1.000	118.00
Massachusetts Institute of Technology	2178	Pri	R1	Phys&Astr	53	53.00	39,598	39,598	-3.86	PHYS01	1.000	118.00
California Institute of Technology	1131	Pri	R1	Phys&Astr	37	37.00	11,558	11,558	-3.25	PHYS01	1.000	118.00
Cornell University, All Campuses	2711	Pri	R1	Phys&Astr	45	45.00	11,842	11,842	-2.73	PHYS02	1.000	201.00
Stanford University	1305	Pri	R1	Phys&Astr	37	37.00	12,557	12,557	-2.29	PHYS02	1.000	201.00
Johns Hopkins University	2077	Pri	R1	Phys&Astr	18	18.00	1,978	1,978	-1.90	PHYS02	1.000	201.00
University of Rochester	2894	Pri	R1	Phys&Astr	30	30.00	4,254	4,254	-1.75	PHYS02	1.000	201.00
Columbia University, Main Campus	2707	Pri	R1	Phys&Astr	33	33.00	1,944	1,944	-1.72	PHYS02	1.000	201.00
University of Chicago	1774	Pri	R1	Phys&Astr	38	38.00	9,716	9,716	-1.34	PHYS02	1.000	201.00
Yale University	1426	Pri	R1	Phys&Astr	39	39.00	5,286	5,286	-1.44	PHYS03	0.818	214.00
Brown University	3401	Pri	R2	Phys&Astr	31	31.00	1,700	1,700	-1.11	PHYS03	0.818	214.00
Princeton University	2627	Pri	R1	Phys&Astr	51	51.00	5,777	5,777	-0.99	PHYS03	0.818	214.00
Catholic University of America	1437	Pri	D1	Phys&Astr	12	12.00	1,316	1,316	-0.93	PHYS03	0.818	214.00
Rice University	3604	Pri	D1	Phys&Astr	21	21.00	2,519	2,519	-0.91	PHYS03	0.818	214.00
Georgetown University	1445	Pri	R2	Phys&Astr	10	10.00	120	120	-0.90	PHYS03	0.818	214.00
Northwestern University	1739	Pri	R1	Phys&Astr	24	24.00	1,263	1,263	-0.77	PHYS03	0.818	214.00
Syracuse University, Main Campus	2882	Pri	R2	Phys&Astr	20	20.00	1,257	1,257	-0.71	PHYS03	0.818	214.00
American University	1434	Pri	D1	Phys&Astr	6	6.00	281	281	-0.68	PHYS03	0.818	214.00
Washington University	2520	Pri	R1	Phys&Astr	26	26.00	1,402	1,402	-0.55	PHYS04	0.488	764.33
New York University	2785	Pri	R1	Phys&Astr	26	26.00	1,658	1,658	-0.51	PHYS04	0.488	764.33
Baylor University	6967	Pri	D2	Phys&Astr	0	6.82	13	13	-0.45	PHYS04	0.488	764.33
Dartmouth College	2573	Pri	D2	Phys&Astr	15	15.00	213	213	-0.41	PHYS04	0.488	764.33
Lehigh University	3289	Pri	D1	Phys&Astr	0	15.65	161	161	-0.39	PHYS04	0.488	764.33
Carnegie Mellon University	3242	Pri	R1	Phys&Astr	30	30.00	1,796	1,796	-0.37	PHYS04	0.488	764.33
University of Pennsylvania	3378	Pri	R1	Phys&Astr	46	46.00	5,442	5,442	-0.32	PHYS04	0.488	764.33
University of Southern California	1328	Pri	R1	Phys&Astr	20	20.00	1,060	1,060	-0.29	PHYS04	0.488	764.33
Howard University	1448	Pri	R1	Phys&Astr	9	9.00	2	2	-0.26	PHYS04	0.488	764.33
Adelphi University	2666	Pri	D2	Phys&Astr	0	8.47	155	155	-0.23	PHYS04	0.488	764.33
Rensselaer Polytechnic Institute	2803	Pri	R2	Phys&Astr	25	25.00	557	557	-0.20	PHYS04	0.488	764.33
Case Western Reserve University	3024	Pri	R1	Phys&Astr	25	25.00	1,338	1,338	-0.13	PHYS04	0.488	764.33
Duke University	2920	Pri	R1	Phys&Astr	19	19.00	1,921	1,921	-0.10	PHYS04	0.488	764.33
Brandeis University	2133	Pri	R2	Phys&Astr	20	20.00	775	775	-0.09	PHYS04	0.488	764.33
Boston University	2130	Pri	R1	Phys&Astr	23	23.00	869	869	-0.08	PHYS04	0.488	764.33
University of Notre Dame	1840	Pri	D1	Phys&Astr	21	21.00	1,025	1,025	0.00	PHYS04	0.488	764.33
Boston College	2128	Pri	D1	Phys&Astr	10	10.00	759	759	0.02	PHYS04	0.488	764.33
Texas Christian University	3636	Pri	D2	Phys&Astr	0	7.07	0	7	0.05	PHYS04	0.488	764.33
Vanderbilt University	3535	Pri	R1	Phys&Astr	18	18.00	800	800	0.06	PHYS04	0.488	764.33
Southern Methodist University	3613	Pri	D2	Phys&Astr	0	5.44	13	13	0.13	PHYS04	0.488	764.33
University of Miami	1536	Pri	R1	Phys&Astr	0	15.14	113	113	0.16	PHYS04	0.488	764.33
Stevens Institute of Technology	2639	Pri	D2	Phys&Astr	19	19.00	661	661	0.17	PHYS04	0.488	764.33
Polytechnic University	2796	Pri	D2	Phys&Astr	11	11.00	189	189	0.19	PHYS04	0.488	764.33
Yeshiva University	2903	Pri	R1	Phys&Astr	0	4.61	30	30	0.27	PHYS04	0.488	764.33
Drexel University	3256	Pri	D2	Phys&Astr	25	25.00	1,178	1,178	0.30	PHYS04	0.488	764.33
Brigham Young University, Main Campus	3670	Pri	D1	Phys&Astr	0	20.65	86	86	0.40	PHYS04	0.488	764.33

Table 5-A.1: Segmentation Array: Physics

School	FICE	TOC	Carnegie Class	Academic Discipline	Faculty	Faculty (adjusted)	R&D Expenditures	R&D Exp (adjusted)	Factor Score	Segment	Segment RU Fraction	Segment Faculty
Northeastern University	2199	Pri	D2	Phys&Astr	32	32.00	1,275	1,275	0.47	PHYS04	0.488	764.33
Clarkson University	2699	Pri	D2	Phys&Astr	11	11.00	292	292	0.48	PHYS04	0.488	764.33
Clark University	2139	Pri	D2	Phys&Astr	0	7.07	115	115	0.53	PHYS04	0.488	764.33
Rockefeller University	2807	Pri	R1	Phys&Astr	15	15.00	1,840	1,840	0.56	PHYS04	0.488	764.33
Tulane University of Louisiana	2029	Pri	R2	Phys&Astr	10	10.00	78	78	0.56	PHYS04	0.488	764.33
Fordham University	2722	Pri	D1	Phys&Astr	0	9.93	1	1	0.70	PHYS04	0.488	764.33
University of Denver	1371	Pri	D1	Phys&Astr	17	17.00	1,374	1,374	0.73	PHYS04	0.488	764.33
Florida Institute of Technology	1469	Pri	D2	Phys&Astr	0	11.43	23	23	0.77	PHYS04	0.488	764.33
Marquette University	3863	Pri	D1	Phys&Astr	0	7.54	3	3	0.79	PHYS04	0.488	764.33
Illinois Institute of Technology	1691	Pri	D1	Phys&Astr	16	16.00	164	164	0.83	PHYS04	0.488	764.33
Drake University	1860	Pri	D2	Phys&Astr	0	4.50	2	2	0.83	PHYS04	0.488	764.33
Clark Atlanta University	1559	Pri	D2	Phys&Astr	0	4.50	5	5	0.92	PHYS04	0.488	764.33
Tufts University	2219	Pri	D1	Phys&Astr	20	20.00	601	601	0.93	PHYS04	0.488	764.33
University of San Francisco	1325	Pri	D2	Phys&Astr	0	8.50	246	246	0.95	PHYS04	0.488	764.33
Emory University	1564	Pri	R2	Phys&Astr	0	24.89	143	143	0.96	PHYS04	0.488	764.33
Andrews University	2238	Pri	D2	Phys&Astr	0	3.67	3	3	0.97	PHYS04	0.488	764.33
George Washington University	1444	Pri	R2	Phys&Astr	0	16.09	63	63	1.00	PHYS04	0.488	764.33
Hofstra University	2732	Pri	D2	Phys&Astr	0	9.93	0	10	1.03	PHYS04	0.488	764.33
University of Tulsa	3185	Pri	D2	Phys&Astr	0	5.44	126	126	1.05	PHYS04	0.488	764.33
Saint Louis University, Main Campus	2506	Pri	D1	Phys&Astr	0	10.20	38	38	1.05	PHYS04	0.488	764.33
Loyola University of Chicago	1710	Pri	D1	Phys&Astr	0	8.59	0	9	1.07	PHYS04	0.488	764.33
Biola University	1122	Pri	D2	Phys&Astr	0	1.92	0	2	1.14	PHYS04	0.488	764.33
Pepperdine University	1264	Pri	D2	Phys&Astr	0	1.92	0	2	1.14	PHYS04	0.488	764.33
Loma Linda University	1218	Pri	D2	Phys&Astr	0	20.01	0	20	1.14	PHYS04	0.488	764.33
Duquesne University	3258	Pri	D2	Phys&Astr	0	4.61	0	5	1.17	PHYS04	0.488	764.33
Saint John's University New York	2823	Pri	D1	Phys&Astr	0	6.24	0	6	1.17	PHYS04	0.488	764.33
Hahnemann University	3,271	Pri	D2	Phys&Astr	0	4.50	0	5	1.19	PHYS04	0.488	764.33
Claremont Univ Center & Graduate School	1169	Pri	D1	Phys&Astr	0 •		0 •		•	PHYS04	0.488	764.33
Nova University	1509	Pri	D1	Phys&Astr	0 •		0 •		•	PHYS04	0.488	764.33
New School For Social Research	2780	Pri	D2	Phys&Astr	0 •		0 •		•	PHYS04	0.488	764.33
Columbia University, Teachers College	3979	Pri	D1	Phys&Astr	0 •		0 •		•	PHYS04	0.488	764.33
Union Institute	10923	Pri	D1	Phys&Astr	0 •		0 •		•	PHYS04	0.488	764.33
University of Arizona	1083	Pub	R1	Phys&Astr	35	35.00	11,377	11,377	-3.09	PHYS05	0.917	144.00
University of California-Santa Cruz	1321	Pub	D1	Phys&Astr	12	12.00	2,486	2,486	-2.25	PHYS05	0.917	144.00
University of California-Los Angeles	1315	Pub	R1	Phys&Astr	46	46.00	6,700	6,700	-2.04	PHYS05	0.917	144.00
University of Oregon	3223	Pub	R2	Phys&Astr	19	19.00	1,121	1,121	-1.94	PHYS05	0.917	144.00
Pennsylvania State U, Main Campus	6965	Pub	R1	Phys&Astr	32	32.00	701	701	-1.86	PHYS05	0.917	144.00
SUNY at Albany	2835	Pub	R2	Phys&Astr	14	14.00	1,208	1,208	-1.90	PHYS06	1.000	249.00
University of California-Berkeley	1312	Pub	R1	Phys&Astr	72	72.00	4,733	4,733	-1.78	PHYS06	1.000	249.00
University of Colorado at Boulder	1370	Pub	R1	Phys&Astr	37	37.00	9,541	9,541	-1.73	PHYS06	1.000	249.00
University of Illinois at Urbana-Champaign	1775	Pub	R1	Phys&Astr	68	68.00	6,539	6,539	-1.54	PHYS06	1.000	249.00
University of Texas at Austin	3658	Pub	R1	Phys&Astr	58	58.00	14,962	14,962	-1.46	PHYS07	1.000	302.00
University of Wisconsin-Madison	3895	Pub	R1	Phys&Astr	54	54.00	6,891	6,891	-1.23	PHYS07	1.000	302.00
University of Maryland at College Park	2103	Pub	R1	Phys&Astr	75	75.00	10,329	10,329	-1.12	PHYS07	1.000	302.00

Table 5-A.1: Segmentation Array: Physics

School	FICE	TOC	Carnegie Class	Academic Discipline	Faculty	Faculty (adjusted)	R&D Expenditures	R&D Exp (adjusted)	Factor Score	Segment	Segment RU Fraction	Segment Faculty
Rutgers, the State University at New Brunswick	6964	Pub	R1	Phys&Astr	41	41.00	2,555	2,555	-1.10	PHYS07	1.000	302.00
University of California-San Diego	1317	Pub	R1	Phys&Astr	38	38.00	14,080	14,080	-1.05	PHYS07	1.000	302.00
Ohio State University, Main Campus	6883	Pub	R1	Phys&Astr	36	36.00	2,091	2,091	-0.96	PHYS07	1.000	302.00
SUNY at Stony Brook, All Campuses	2838	Pub	R1	Phys&Astr	52	52.00	4,157	4,157	-0.98	PHYS08	0.966	354.96
Purdue University, Main Campus	1825	Pub	R1	Phys&Astr	0	38.96	2,779	2,779	-0.98	PHYS08	0.966	354.96
University of California-Irvine	1314	Pub	R1	Phys&Astr	23	23.00	3,387	3,387	-0.83	PHYS08	0.966	354.96
University of Washington	3798	Pub	R1	Phys&Astr	45	45.00	4,104	4,104	-0.81	PHYS08	0.966	354.96
Georgia Institute of Technology, Main Campus	1569	Pub	R1	Phys&Astr	23	23.00	2,023	2,023	-0.80	PHYS08	0.966	354.96
University of Utah	3675	Pub	R1	Phys&Astr	17	17.00	1,047	1,047	-0.77	PHYS08	0.966	354.96
SUNY at Buffalo, Main Campus	2837	Pub	R2	Phys&Astr	12	12.00	321	321	-0.75	PHYS08	0.966	354.96
Florida State University	1489	Pub	R2	Phys&Astr	27	27.00	2,699	2,699	-0.70	PHYS08	0.966	354.96
University of Iowa	1892	Pub	R1	Phys&Astr	22	22.00	6,162	6,162	-0.69	PHYS08	0.966	354.96
University of California-Santa Barbara	1320	Pub	R2	Phys&Astr	23	23.00	1,713	1,713	-0.69	PHYS08	0.966	354.96
University of North Texas	3594	Pub	D1	Phys&Astr	12	12.00	399	399	-0.65	PHYS08	0.966	354.96
University of Virginia, Main Campus	6968	Pub	R1	Phys&Astr	31	31.00	1,732	1,732	-0.60	PHYS08	0.966	354.96
New Mexico State University, All Campuses	2657	Pub	R1	Phys&Astr	13	13.00	429	429	-0.51	PHYS08	0.966	354.96
Washington State University	3800	Pub	R2	Phys&Astr	16	16.00	442	442	-0.36	PHYS08	0.966	354.96
University of Louisville	1999	Pub	D1	Phys&Astr	0	7.54	19	19	-0.91	PHYS09	0.877	459.54
University of Massachusetts at Amherst	2221	Pub	R2	Phys&Astr	35	35.00	2,132	2,132	-0.38	PHYS09	0.877	459.54
University of South Carolina at Columbia	3448	Pub	R2	Phys&Astr	17	17.00	128	128	-0.35	PHYS09	0.877	459.54
Indiana University at Bloomington	1809	Pub	R1	Phys&Astr	42	42.00	5,420	5,420	-0.24	PHYS09	0.877	459.54
University of California-Davis	1313	Pub	R1	Phys&Astr	22	22.00	1,283	1,283	-0.22	PHYS09	0.877	459.54
University of California-Riverside	1316	Pub	D1	Phys&Astr	20	20.00	1,010	1,010	-0.19	PHYS09	0.877	459.54
University of Pittsburgh Main Campus	3379	Pub	R1	Phys&Astr	42	42.00	2,764	2,764	-0.17	PHYS09	0.877	459.54
University of Minnesota at Twin Cities	3969	Pub	R1	Phys&Astr	46	46.00	3,912	3,912	-0.16	PHYS09	0.877	459.54
Montana State University	2532	Pub	D2	Phys&Astr	13	13.00	718	718	-0.15	PHYS09	0.877	459.54
Arizona State University	1081	Pub	R2	Phys&Astr	18	18.00	390	390	-0.15	PHYS09	0.877	459.54
University of Cincinnati, All Campuses	3125	Pub	R1	Phys&Astr	24	24.00	150	150	-0.06	PHYS09	0.877	459.54
University of Florida	1535	Pub	R1	Phys&Astr	25	25.00	1,306	1,306	-0.04	PHYS09	0.877	459.54
Colorado State University	1350	Pub	R1	Phys&Astr	21	21.00	413	413	-0.02	PHYS09	0.877	459.54
Kent State University, All Campuses	3051	Pub	D1	Phys&Astr	16	16.00	303	303	0.02	PHYS09	0.877	459.54
University of Connecticut, Main Campus	29013	Pub	R1	Phys&Astr	31	31.00	1,465	1,465	0.04	PHYS09	0.877	459.54
University of Michigan at Ann Arbor	9092	Pub	R1	Phys&Astr	50	50.00	4,470	4,470	0.06	PHYS09	0.877	459.54
University of North Carolina at Chapel Hill	2974	Pub	R1	Phys&Astr	30	30.00	587	587	0.11	PHYS09	0.877	459.54
West Virginia University	3827	Pub	R2	Phys&Astr	0	12.00	296	296	-0.06	PHYS10	0.544	1346.27
Michigan State University	2290	Pub	R1	Phys&Astr	48	48.00	2,234	2,234	0.10	PHYS10	0.544	1346.27
University of Texas at Dallas	9741	Pub	D2	Phys&Astr	21	21.00	3,122	3,122	0.13	PHYS10	0.544	1346.27
University of Missouri, Rolla	2517	Pub	D2	Phys&Astr	22	22.00	1,198	1,198	0.13	PHYS10	0.544	1346.27
East Texas State University, All Campuses	3565	Pub	D2	Phys&Astr	0	8.23	20	20	0.14	PHYS10	0.544	1346.27
Miami University, All Campuses	7104	Pub	D1	Phys&Astr	0	11.42	150	150	0.16	PHYS10	0.544	1346.27
University of Missouri, Columbia	2516	Pub	R1	Phys&Astr	19	19.00	273	273	0.17	PHYS10	0.544	1346.27
University of Delaware	1431	Pub	R2	Phys&Astr	24	24.00	464	464	0.17	PHYS10	0.544	1346.27
North Carolina State University at Raleigh	2972	Pub	R1	Phys&Astr	31	31.00	818	818	0.19	PHYS10	0.544	1346.27
University of Wisconsin-Milwaukee	3896	Pub	D1	Phys&Astr	17	17.00	324	324	0.20	PHYS10	0.544	1346.27

Table 5-A.1: Segmentation Array: Physics

School	FICE	TOC	Carnegie Class	Academic Discipline	Faculty	Faculty (adjusted)	R&D Expenditures	R&D Exp (adjusted)	Factor Score	Segment	Segment RU Fraction	Segment Faculty
Auburn University, Main Campus	1009	Pub	R2	Phys&Astr	13	13.00	151	151	0.20	PHYS10	0.544	1346.27
University of Hawaii at Manoa	1610	Pub	R1	Phys&Astr	0	29.71	6,478	6,478	0.21	PHYS10	0.544	1346.27
University of Vermont	3696	Pub	D2	Phys&Astr	0	12.05	169	169	0.21	PHYS10	0.544	1346.27
Wayne State University	2329	Pub	R2	Phys&Astr	24	24.00	387	387	0.23	PHYS10	0.544	1346.27
Iowa State University	1869	Pub	R2	Phys&Astr	43	43.00	349	349	0.23	PHYS10	0.544	1346.27
University of Alabama at Birmingham	1052	Pub	D2	Phys&Astr	0	9.17	1	1	0.26	PHYS10	0.544	1346.27
Texas A & M University, Main Campus	10366	Pub	R1	Phys&Astr	35	35.00	1,330	1,330	0.27	PHYS10	0.544	1346.27
Oklahoma State University, All Campuses	3170	Pub	R2	Phys&Astr	22	22.00	474	474	0.27	PHYS10	0.544	1346.27
University of Arkansas, Main Campus	1108	Pub	D1	Phys&Astr	0	11.42	429	429	0.28	PHYS10	0.544	1346.27
University of Oklahoma, Norman Campus	3184	Pub	R2	Phys&Astr	22	22.00	419	419	0.28	PHYS10	0.544	1346.27
University of Idaho	1626	Pub	D2	Phys&Astr	0	6.23	23	23	0.29	PHYS10	0.544	1346.27
University of Illinois at Chicago	1776	Pub	R1	Phys&Astr	28	28.00	1,229	1,229	0.29	PHYS10	0.544	1346.27
University of Houston-University Park	3652	Pub	D1	Phys&Astr	18	18.00	735	735	0.32	PHYS10	0.544	1346.27
University of Maine at Orono	2053	Pub	D2	Phys&Astr	0	15.44	693	693	0.32	PHYS10	0.544	1346.27
Clemson University	3425	Pub	D1	Phys&Astr	23	23.00	158	158	0.37	PHYS10	0.544	1346.27
Ohio University, All Campuses	3100	Pub	D1	Phys&Astr	19	19.00	485	485	0.38	PHYS10	0.544	1346.27
University of Akron, All Campuses	3123	Pub	D1	Phys&Astr	0	7.54	0	8	0.39	PHYS10	0.544	1346.27
Texas Tech University	3644	Pub	D1	Phys&Astr	0	11.76	85	85	0.40	PHYS10	0.544	1346.27
College of William and Mary	3705	Pub	D1	Phys&Astr	24	24.00	468	468	0.43	PHYS10	0.544	1346.27
Indiana State University, Terre Haute	9563	Pub	D2	Phys&Astr	0	8.91	10	10	0.44	PHYS10	0.544	1346.27
Utah State University	3677	Pub	R2	Phys&Astr	15	15.00	101	101	0.45	PHYS10	0.544	1346.27
Northern Illinois University	1737	Pub	D1	Phys&Astr	0	14.34	479	479	0.46	PHYS10	0.544	1346.27
University of New Mexico, All Campuses	10313	Pub	R1	Phys&Astr	22	22.00	495	495	0.47	PHYS10	0.544	1346.27
University of New Hampshire, Main Campus	2589	Pub	D2	Phys&Astr	17	17.00	1,922	1,922	0.49	PHYS10	0.544	1346.27
University of Nebraska at Lincoln	2565	Pub	R2	Phys&Astr	30	30.00	1,045	1,045	0.50	PHYS10	0.544	1346.27
Tennessee Technological University	3523	Pub	D2	Phys&Astr	0	5.30	22	22	0.51	PHYS10	0.544	1346.27
Ball State University	1786	Pub	D1	Phys&Astr	0	9.56	6	6	0.52	PHYS10	0.544	1346.27
University of Wyoming	3932	Pub	R2	Phys&Astr	18	18.00	807	807	0.54	PHYS10	0.544	1346.27
University of Tennessee at Knoxville	3530	Pub	R1	Phys&Astr	43	43.00	0	36	0.54	PHYS10	0.544	1346.27
North Dakota State University, All Campuses	9265	Pub	D2	Phys&Astr	0	6.82	20	20	0.55	PHYS10	0.544	1346.27
University of Georgia	1598	Pub	R1	Phys&Astr	0	18.51	541	541	0.57	PHYS10	0.544	1346.27
University of Texas at Arlington	3656	Pub	D2	Phys&Astr	0	15.65	134	134	0.57	PHYS10	0.544	1346.27
Bowling Green State University, All Campuses	3018	Pub	D1	Phys&Astr	0	10.00	11	11	0.58	PHYS10	0.544	1346.27
Virginia Polytechnic Institute and State Univ	3754	Pub	R1	Phys&Astr	36	36.00	992	992	0.58	PHYS10	0.544	1346.27
Oregon State University	3210	Pub	R1	Phys&As	17	17.00	292	292	0.58	PHYS10	0.544	1346.27
University of Missouri, Kansas City	2518	Pub	D2	Phys&Astr	0	5.30	44	44	0.60	PHYS10	0.544	1346.27
University of Toledo	3131	Pub	D1	Phys&Astr	0	14.62	298	298	0.62	PHYS10	0.544	1346.27
University of Missouri, Saint Louis	2519	Pub	D2	Phys&Astr	0	12.72	240	240	0.63	PHYS10	0.544	1346.27
Old Dominion University	3728	Pub	D2	Phys&Astr	0	17.31	233	233	0.64	PHYS10	0.544	1346.27
University of New Orleans	2015	Pub	D2	Phys&Astr	0	14.62	108	108	0.66	PHYS10	0.544	1346.27
University of Northern Colorado	1349	Pub	D1	Phys&Astr	0	5.30	0	5	0.66	PHYS10	0.544	1346.27
University of Kansas, Main Campus	1948	Pub	R2	Phys&Astr	24	24.00	273	273	0.66	PHYS10	0.544	1346.27
Georgia State University	1574	Pub	D1	Phys&Astr	0	10.50	103	103	0.68	PHYS10	0.544	1346.27
SUNY at Binghamton	2836	Pub	D1	Phys&Astr	0	10.68	98	98	0.71	PHYS10	0.544	1346.27

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Table 5-A.1: Segmentation Array: Physics

School	FICE	TOC	Carnegie Class	Academic Discipline	Faculty	Faculty (adjusted)	R&D Expenditures	R&D Exp (adjusted)	Factor Score	Segment	Segment RU Fraction	Segment Faculty
Florida Atlantic University	1481	Pub	D2	Phys&Astr	0	7.75	54	54	0.72	PHYS10	0.544	1346.27
University of Kentucky, Main Campus	1989	Pub	R1	Phys&Astr	22	22.00	203	203	0.75	PHYS10	0.544	1346.27
Western Michigan University	2330	Pub	D1	Phys&Astr	0	8.91	13	13	0.76	PHYS10	0.544	1346.27
University of South Florida	1537	Pub	D1	Phys&Astr	0	18.89	83	83	0.80	PHYS10	0.544	1346.27
Mississippi State University	2423	Pub	R2	Phys&Astr	0	9.56	27	27	0.81	PHYS10	0.544	1346.27
Kansas State University of Agriculture and App	1928	Pub	R2	Phys&Astr	24	24.00	221	221	0.82	PHYS10	0.544	1346.27
University of North Carolina at Greensboro	2976	Pub	D2	Phys&Astr	0	6.82	2	2	0.83	PHYS10	0.544	1346.27
University of Nevada-Reno	2568	Pub	D2	Phys&Astr	12	12.00	12	12	0.85	PHYS10	0.544	1346.27
University of Alabama	1051	Pub	D1	Phys&Astr	0	15.22	133	133	0.85	PHYS10	0.544	1346.27
Portland State University	3216	Pub	D2	Phys&Astr	0	12.59	122	122	0.87	PHYS10	0.544	1346.27
Temple University	3371	Pub	R2	Phys&Astr	24	24.00	435	435	0.87	PHYS10	0.544	1346.27
University of Mississippi, Main Campus	2440	Pub	D1	Phys&Astr	0	10.20	207	207	0.89	PHYS10	0.544	1346.27
Virginia Commonwealth University	3735	Pub	R2	Phys&Astr	0	6.07	1	1	0.90	PHYS10	0.544	1346.27
Illinois State University	1692	Pub	D2	Phys&Astr	0	10.20	0	10	0.91	PHYS10	0.544	1346.27
University of Maryland Baltimore County	2105	Pub	D2	Phys&Astr	0	11.43	14	14	0.91	PHYS10	0.544	1346.27
Northern Arizona University	1082	Pub	D2	Phys&Astr	0	8.91	6	6	0.91	PHYS10	0.544	1346.27
Colorado School of Mines	1348	Pub	D2	Phys&Astr	0	12.36	117	117	0.93	PHYS10	0.544	1346.27
University of North Dakota, All Campuses	3005	Pub	D2	Phys&Astr	0	7.54	12	12	0.94	PHYS10	0.544	1346.27
Cleveland State University	3032	Pub	D2	Phys&Astr	0	10.50	5	5	0.98	PHYS10	0.544	1346.27
University of Rhode Island	3414	Pub	R2	Phys&Astr	0	11.42	0	11	1.04	PHYS10	0.544	1346.27
Memphis State University	3509	Pub	D1	Phys&Astr	0	10.05	6	6	1.07	PHYS10	0.544	1346.27
Idaho State University	1620	Pub	D2	Phys&Astr	0	4.50	4	4	1.09	PHYS10	0.544	1346.27
University of Southern Mississippi	2441	Pub	D1	Phys&Astr	0	4.50	3	3	1.12	PHYS10	0.544	1346.27
Middle Tennesse State University	3510	Pub	D2	Phys&Astr	0	6.07	0	6	1.12	PHYS10	0.544	1346.27
Texas Woman's University	3646	Pub	D1	Phys&Astr	0	2.81	41	41	1.13	PHYS10	0.544	1346.27
University of Montana	2536	Pub	D1	Phys&Astr	0	4.50	11	11	1.14	PHYS10	0.544	1346.27
Louisiana Tech University	2008	Pub	D2	Phys&Astr	0	7.54	0	8	1.14	PHYS10	0.544	1346.27
Southern Illinois University-Carbondale	1758	Pub	R2	Phys&Astr	61	61.00	26	26	1.15	PHYS10	0.544	1346.27
University of South Dakota	3474	Pub	D2	Phys&Astr	0	2.81	0	3	1.19	PHYS10	0.544	1346.27
University of California-San Francisco	1319	Pub	R1	Phys&Astr	0 •		235	235	•	PHYS10	0.544	1346.27
Louisiana State University and Agric & Mech Co	2010	Pub	R1	Phys&Astr	0 •		0 •		•	PHYS10	0.544	1346.27
SUNY College of Environmental Science and F	2851	Pub	D2	Phys&Astr	0 •		0 •		•	PHYS10	0.544	1346.27
CUNY Graduate School and University Center	4063	Pub	D1	Phys&Astr	51	51.00	0 •		•	PHYS10	0.544	1346.27

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Table 5-A.2: Segmentation Array: Biological Sciences

School	FICE	TOC	Carnegie Class	Academic Discipline	Faculty	Faculty (adjusted)	R&D Expenditures	R&D Exp (adjusted)	Factor Score	Segment	Segment RU Fraction	Segment Faculty
George Washington University	1444	Pri	R2	BioSci	19	19.00	1,189	1,189	-3.34	BIOL01	0.867	602
Johns Hopkins University	2077	Pri	R1	BioSci	46	46.00	26,459	26,459	-2.85	BIOL01	0.867	602
California Institute of Technology	1131	Pri	R1	BioSci	23	23.00	6,206	6,206	-2.62	BIOL01	0.867	602
Dartmouth College	2573	Pri	D2	BioSci	10	10.00	4,949	4,949	-2.17	BIOL01	0.867	602
Catholic University of America	1437	Pri	D1	BioSci	6	6.00	161	161	-1.24	BIOL01	0.867	602
Georgetown University	1445	Pri	R2	BioSci	30	30.00	4,333	4,333	-1.06	BIOL01	0.867	602
Stanford University	1305	Pri	R1	BioSci	60	60.00	2,858	2,858	-1.05	BIOL01	0.867	602
Harvard University	2155	Pri	R1	BioSci	155	155.00	39,566	39,566	-0.96	BIOL01	0.867	602
Brigham Young University, Main Campus	3670	Pri	D1	BioSci	22	22.00	1,321	1,321	-0.91	BIOL01	0.867	602
Loyola University of Chicago	1710	Pri	D1	BioSci	32	32.00	15	15	-0.91	BIOL01	0.867	602
Clark Atlanta University	1559	Pri	D2	BioSci	10	10.00	376	376	-0.89	BIOL01	0.867	602
Brandeis University	2133	Pri	R2	BioSci	27	27.00	5,284	5,284	-0.74	BIOL01	0.867	602
New York University	2785	Pri	R1	BioSci	81	81.00	10,536	10,536	-0.63	BIOL01	0.867	602
University of Rochester	2894	Pri	R1	BioSci	81	81.00	17,170	17,170	-0.48	BIOL01	0.867	602
Princeton University	2627	Pri	R1	BioSci	32	32.00	3,609	3,609	-0.44	BIOL02	0.758	1090.75
Loma Linda University	1218	Pri	D2	BioSci	15	15.00	437	437	-0.35	BIOL02	0.758	1090.75
Union Institute	10923	Pri	D1	BioSci	0	0.99	0	1	-0.28	BIOL02	0.758	1090.75
Rice University	3604	Pri	D1	BioSci	24	24.00	1,432	1,432	-0.27	BIOL02	0.758	1090.75
Saint Louis University, Main Campus	2506	Pri	D1	BioSci	28	28.00	3,674	3,674	-0.26	BIOL02	0.758	1090.75
Vanderbilt University	3535	Pri	R1	BioSci	71	71.00	9,202	9,202	-0.19	BIOL02	0.758	1090.75
Case Western Reserve University	3024	Pri	R1	BioSci	65	65.00	8,570	8,570	-0.18	BIOL02	0.758	1090.75
Illinois Institute of Technology	1691	Pri	D1	BioSci	10	10.00	201	201	-0.15	BIOL02	0.758	1090.75
Saint John's University New York	2823	Pri	D1	BioSci	0	17.02	95	95	-0.12	BIOL02	0.758	1090.75
University of Miami	1536	Pri	R1	BioSci	57	57.00	6,073	6,073	-0.10	BIOL02	0.758	1090.75
Tufts University	2219	Pri	D1	BioSci	47	47.00	4,843	4,843	-0.08	BIOL02	0.758	1090.75
Syracuse University, Main Campus	2882	Pri	R2	BioSci	30	30.00	2,362	2,362	-0.07	BIOL02	0.758	1090.75
Hahnemann University	3271	Pri	D2	BioSci	14	14.00	272	272	-0.06	BIOL02	0.758	1090.75
Northeastern University	2199	Pri	D2	BioSci	0	18.38	608	608	-0.05	BIOL02	0.758	1090.75
Columbia University, Main Campus	2707	Pri	R1	BioSci	92	92.00	12,908	12,908	0.05	BIOL02	0.758	1090.75
Cornell University, All Campuses	2711	Pri	R1	BioSci	198	198.00	17,334	17,334	0.08	BIOL02	0.758	1090.75
Emory University	1564	Pri	R2	BioSci	40	40.00	3,131	3,131	0.09	BIOL02	0.758	1090.75
University of Notre Dame	1840	Pri	D1	BioSci	33	33.00	1,327	1,327	0.11	BIOL02	0.758	1090.75
Lehigh University	3289	Pri	D1	BioSci	0	9.35	196	196	0.17	BIOL02	0.758	1090.75
Duquesne University	3258	Pri	D2	BioSci	0	8.47	0	8	0.20	BIOL02	0.758	1090.75
Nova University	1509	Pri	D1	BioSci	0	2.94	86	86	0.24	BIOL02	0.758	1090.75
Drexel University	3256	Pri	D2	BioSci	0	15.66	286	286	0.25	BIOL02	0.758	1090.75
Boston College	2128	Pri	D1	BioSci	0	19.94	313	313	0.25	BIOL02	0.758	1090.75
Massachusetts Institute of Technology	2178	Pri	R1	BioSci	159	159.00	19,033	19,033	0.26	BIOL02	0.758	1090.75
Yeshiva University	2903	Pri	R1	BioSci	83	83.00	11,202	11,202	0.27	BIOL02	0.758	1090.75
University of Chicago	1774	Pri	R1	BioSci	171	171.00	18,442	18,442	0.27	BIOL03	0.882	2119.13
Fordham University	2722	Pri	D1	BioSci	0	24.96	87	87	0.29	BIOL03	0.882	2119.13
Marquette University	3863	Pri	D1	BioSci	17	17.00	440	440	0.30	BIOL03	0.882	2119.13
Howard University	1448	Pri	R1	BioSci	39	39.00	2,575	2,575	0.30	BIOL03	0.882	2119.13
University of Southern California	1328	Pri	R1	BioSci	85	85.00	1,473	1,473	0.31	BIOL03	0.882	2119.13

Table 5-A.2: Segmentation Array: Biological Sciences

School	FICE	TOC	Carnegie Class	Academic Discipline	Faculty	Faculty (adjusted)	R&D Expenditures	R&D Exp (adjusted)	Factor Score	Segment	Segment RU Fraction	Segment Faculty
Tulane University of Louisiana	2029	Pri	R2	BioSci	54	54.00	3,901	3,901	0.33	BIOL03	0.882	2119.13
Clark University	2139	Pri	D2	BioSci	0	12.17	145	145	0.44	BIOL03	0.882	2119.13
Florida Institute of Technology	1469	Pri	D2	BioSci	0	13.76	200	200	0.44	BIOL03	0.882	2119.13
Baylor University	6967	Pri	D2	BioSci	0	12.92	55	55	0.44	BIOL03	0.882	2119.13
Yale University	1426	Pri	R1	BioSci	277	277.00	21,201	21,201	0.49	BIOL03	0.882	2119.13
University of Pennsylvania	3378	Pri	R1	BioSci	255	255.00	28,620	28,620	0.50	BIOL03	0.882	2119.13
Northwestern University	1739	Pri	R1	BioSci	115	115.00	7,434	7,434	0.51	BIOL03	0.882	2119.13
Rockefeller University	2807	Pri	R1	BioSci	153	153.00	29,383	29,383	0.51	BIOL03	0.882	2119.13
Washington University	2520	Pri	R1	BioSci	190	190.00	16,586	16,586	0.51	BIOL03	0.882	2119.13
Rensselaer Polytechnic Institute	2803	Pri	R2	BioSci	17	17.00	427	427	0.52	BIOL03	0.882	2119.13
Boston University	2130	Pri	R1	BioSci	119	119.00	1,333	1,333	0.56	BIOL03	0.882	2119.13
Hofstra University	2732	Pri	D2	BioSci	0	20.90	47	47	0.56	BIOL03	0.882	2119.13
Claremont Univ Center & Graduate School	1169	Pri	D1	BioSci	5	5.00	13	13	0.60	BIOL03	0.882	2119.13
Brown University	3401	Pri	R2	BioSci	57	57.00	1,200	1,200	0.62	BIOL03	0.882	2119.13
Andrews University	2238	Pri	D2	BioSci	0	6.67	21	21	0.63	BIOL03	0.882	2119.13
University of San Francisco	1325	Pri	D2	BioSci	0	14.93	85	85	0.65	BIOL03	0.882	2119.13
American University	1434	Pri	D1	BioSci	0	13.18	65	65	0.67	BIOL03	0.882	2119.13
Adelphi University	2666	Pri	D2	BioSci	0	20.33	41	41	0.73	BIOL03	0.882	2119.13
Duke University	2920	Pri	R1	BioSci	285	285.00	13,332	13,332	0.77	BIOL03	0.882	2119.13
University of Denver	1371	Pri	D1	BioSci	0	16.03	278	278	0.88	BIOL03	0.882	2119.13
Southern Methodist University	3613	Pri	D2	BioSci	0	12.24	126	126	0.91	BIOL03	0.882	2119.13
Texas Christian University	3636	Pri	D2	BioSci	0	12.92	28	28	0.94	BIOL03	0.882	2119.13
Pepperdine University	1264	Pri	D2	BioSci	0	2.94	0	3	0.95	BIOL03	0.882	2119.13
Carnegie Mellon University	3242	Pri	R1	BioSci	0	53.02	6,226	6,226	0.96	BIOL03	0.882	2119.13
University of Tulsa	3185	Pri	D2	BioSci	0	10.34	0	10	1.02	BIOL03	0.882	2119.13
Drake University	1860	Pri	D2	BioSci	0	19.13	14	14	1.07	BIOL03	0.882	2119.13
Clarkson University	2699	Pri	D2	BioSci	0	3.89	9	9	1.11	BIOL03	0.882	2119.13
Polytechnic University	2796	Pri	D2	BioSci	0	2.94	32	32	1.12	BIOL03	0.882	2119.13
Biola University	1122	Pri	D2	BioSci	0	4.88	0	5	1.14	BIOL03	0.882	2119.13
Columbia University, Teachers College	3979	Pri	D1	BioSci	0	1.97	0	2	1.28	BIOL03	0.882	2119.13
Stevens Institute of Technology	2639	Pri	D2	BioSci	0	0.00	0	0	•	BIOL03	0.882	2119.13
New School For Social Research	2780	Pri	D2	BioSci	0	0.00	0	0	•	BIOL03	0.882	2119.13
University of Mississippi, Main Campus	2440	Pub	D1	BioSci	4	4.00	2,890	2,890	-6.42	BIOL04	0.742	726.00
University of Southern Mississippi	2441	Pub	D1	BioSci	3	3.00	202	202	-5.50	BIOL04	0.742	726.00
Northern Illinois University	1737	Pub	D1	BioSci	5	5.00	526	526	-3.54	BIOL04	0.742	726.00
University of North Texas	3594	Pub	D1	BioSci	6	6.00	235	235	-3.20	BIOL04	0.742	726.00
University of South Florida	1537	Pub	D1	BioSci	11	11.00	1,465	1,465	-2.24	BIOL04	0.742	726.00
University of Vermont	3696	Pub	D2	BioSci	17	17.00	5,063	5,063	-2.09	BIOL04	0.742	726.00
Montana State University	2532	Pub	D2	BioSci	10	10.00	1,105	1,105	-1.58	BIOL04	0.742	726.00
University of Idaho	1626	Pub	D2	BioSci	10	10.00	1,791	1,791	-1.55	BIOL04	0.742	726.00
Texas Tech University	3644	Pub	D1	BioSci	16	16.00	1,194	1,194	-1.54	BIOL04	0.742	726.00
University of Illinois at Chicago	1776	Pub	R1	BioSci	66	66.00	6,906	6,906	-1.15	BIOL04	0.742	726.00
SUNY at Stony Brook, All Campuses	2838	Pub	R1	BioSci	52	52.00	6,841	6,841	-1.05	BIOL04	0.742	726.00
Texas Woman's University	3646	Pub	D1	BioSci	10	10.00	471	471	-0.99	BIOL04	0.742	726.00

Table 5-A.2: Segmentation Array: Biological Sciences

School	FICE	TOC	Carnegie Class	Academic Discipline	Faculty	Faculty (adjusted)	R&D Expenditures	R&D Exp (adjusted)	Factor Score	Segment	Segment RU Fraction	Segment Faculty
North Dakota State University, All Campuses	9265	Pub	D2	BioSci	19	19.00	7,185	7,185	-0.89	BIOL04	0.742	726.00
University of Montana	2536	Pub	D1	BioSci	10	10.00	332	332	-0.77	BIOL04	0.742	726.00
University of Connecticut, Main Campus	29013	Pub	R1	BioSci	75	75.00	16,405	16,405	-0.74	BIOL04	0.742	726.00
University of Arizona	1083	Pub	R1	BioSci	88	88.00	9,418	9,418	-0.67	BIOL04	0.742	726.00
Idaho State University	1620	Pub	D2	BioSci	12	12.00	490	490	-0.66	BIOL04	0.742	726.00
University of California-Riverside	1316	Pub	D1	BioSci	54	54.00	2,171	2,171	-0.56	BIOL04	0.742	726.00
University of Delaware	1431	Pub	R2	BioSci	16	16.00	1,006	1,006	-0.55	BIOL04	0.742	726.00
University of Wyoming	3932	Pub	R2	BioSci	22	22.00	1,063	1,063	-0.55	BIOL04	0.742	726.00
Kansas State University of Agriculture and App	1928	Pub	R2	BioSci	48	48.00	3,054	3,054	-0.52	BIOL04	0.742	726.00
University of California-Berkeley	1312	Pub	R1	BioSci	172	172.00	11,420	11,420	-0.50	BIOL04	0.742	726.00
University of Cincinnati, All Campuses	3125	Pub	R1	BioSci	49	49.00	11,639	11,639	-0.48	BIOL05	0.955	804.00
Texas A & M University, Main Campus	10366	Pub	R1	BioSci	70	70.00	2,459	2,459	-0.48	BIOL05	0.955	804.00
University of Wisconsin-Madison	3895	Pub	R1	BioSci	208	208.00	24,392	24,392	-0.45	BIOL05	0.955	804.00
Temple University	3371	Pub	R2	BioSci	43	43.00	7,282	7,282	-0.41	BIOL05	0.955	804.00
Arizona State University	1081	Pub	R2	BioSci	24	24.00	1,601	1,601	-0.36	BIOL05	0.955	804.00
SUNY at Albany	2835	Pub	R2	BioSci	22	22.00	1,340	1,340	-0.33	BIOL05	0.955	804.00
University of Colorado at Boulder	1370	Pub	R1	BioSci	84	84.00	7,595	7,595	-0.33	BIOL05	0.955	804.00
University of Washington	3798	Pub	R1	BioSci	146	146.00	15,847	15,847	-0.29	BIOL05	0.955	804.00
University of Massachusetts at Amherst	2221	Pub	R2	BioSci	56	56.00	2,329	2,329	-0.26	BIOL05	0.955	804.00
University of Houston-University Park	3652	Pub	D1	BioSci	36	36.00	1,562	1,562	-0.25	BIOL05	0.955	804.00
Virginia Commonwealth University	3735	Pub	R2	BioSci	66	66.00	7,398	7,398	-0.21	BIOL05	0.955	804.00
Purdue University, Main Campus	1825	Pub	R1	BioSci	91	91.00	12,036	12,036	-0.20	BIOL06	0.868	1129.57
Clemson University	3425	Pub	D1	BioSci	37	37.00	3,379	3,379	-0.16	BIOL06	0.868	1129.57
University of Maine at Orono	2053	Pub	D2	BioSci	20	20.00	2,055	2,055	-0.15	BIOL06	0.868	1129.57
University of New Hampshire, Main Campus	2589	Pub	D2	BioSci	30	30.00	2,350	2,350	-0.12	BIOL06	0.868	1129.57
Wayne State University	2329	Pub	R2	BioSci	95	95.00	7,164	7,164	-0.12	BIOL06	0.868	1129.57
Washington State University	3800	Pub	R2	BioSci	69	69.00	1,207	1,207	-0.12	BIOL06	0.868	1129.57
University of California-Santa Cruz	1321	Pub	D1	BioSci	0	27.57	902	902	-0.09	BIOL06	0.868	1129.57
University of Minnesota at Twin Cities	3969	Pub	R1	BioSci	199	199.00	16,572	16,572	-0.07	BIOL06	0.868	1129.57
University of Tennessee at Knoxville	3530	Pub	R1	BioSci	69	69.00	0	77	-0.07	BIOL06	0.868	1129.57
University of Georgia	1598	Pub	R1	BioSci	101	101.00	9,986	9,986	-0.04	BIOL06	0.868	1129.57
University of Virginia, Main Campus	6968	Pub	R1	BioSci	65	65.00	6,335	6,335	-0.04	BIOL06	0.868	1129.57
Ohio University, All Campuses	3100	Pub	D1	BioSci	19	19.00	471	471	-0.01	BIOL06	0.868	1129.57
University of Utah	3675	Pub	R1	BioSci	75	75.00	8,764	8,764	-0.01	BIOL06	0.868	1129.57
Kent State University, All Campuses	3051	Pub	D1	BioSci	16	16.00	36	36	0.02	BIOL06	0.868	1129.57
Indiana University at Bloomington	1809	Pub	R1	BioSci	111	111.00	5,877	5,877	0.03	BIOL06	0.868	1129.57
University of Kansas, Main Campus	1948	Pub	R2	BioSci	105	105.00	4,548	4,548	0.03	BIOL06	0.868	1129.57
Florida State University	1489	Pub	R2	BioSci	58	58.00	3,861	3,861	0.07	BIOL07	1.000	1132.00
Michigan State University	2290	Pub	R1	BioSci	193	193.00	13,653	13,653	0.07	BIOL07	1.000	1132.00
Oregon State University	3210	Pub	R1	BioSci	79	79.00	7,837	7,837	0.08	BIOL07	1.000	1132.00
University of Iowa	1892	Pub	R1	BioSci	103	103.00	9,844	9,844	0.10	BIOL07	1.000	1132.00
University of Illinois at Urbana-Champaign	1775	Pub	R1	BioSci	178	178.00	7,184	7,184	0.13	BIOL07	1.000	1132.00
University of Maryland at College Park	2103	Pub	R1	BioSci	86	86.00	1,597	1,597	0.13	BIOL07	1.000	1132.00
West Virginia University	3827	Pub	R2	BioSci	61	61.00	2,719	2,719	0.13	BIOL07	1.000	1132.00

Table 5-A.2: Segmentation Array: Biological Sciences

School	FICE	TOC	Carnegie Class	Academic Discipline	Faculty	Faculty (adjusted)	R&D Expenditures	R&D Exp (adjusted)	Factor Score	Segment	Segment RU Fraction	Segment Faculty
Ohio State University, Main Campus	6883	Pub	R1	BioSci	203	203.00	11,724	11,724	0.17	BIOL07	1.000	1132.00
University of California-Santa Barbara	1320	Pub	R2	BioSci	55	55.00	1,399	1,399	0.18	BIOL07	1.000	1132.00
Mississippi State University	2,423	Pub	R2	BioSci	26	26.00	2,010	2,010	0.19	BIOL07	1.000	1132.00
University of Missouri, Columbia	2516	Pub	R1	BioSci	90	90.00	6,194	6,194	0.21	BIOL07	1.000	1132.00
University of New Mexico, All Campuses	10313	Pub	R1	BioSci	0	45.35	3,586	3,586	0.21	BIOL08	0.980	1303.95
University of California-Irvine	1314	Pub	R1	BioSci	93	93.00	3,998	3,998	0.22	BIOL08	0.980	1303.95
Pennsylvania State U, Main Campus	6965	Pub	R1	BioSci	148	148.00	8,742	8,742	0.23	BIOL08	0.980	1303.95
University of California-Los Angeles	1315	Pub	R1	BioSci	212	212.00	5,142	5,142	0.24	BIOL08	0.980	1303.95
Western Michigan University	2330	Pub	D1	BioSci	0	13.60	64	64	0.25	BIOL08	0.980	1303.95
University of California-San Diego	1317	Pub	R1	BioSci	132	132.00	13,095	13,095	0.25	BIOL08	0.980	1303.95
Utah State University	3677	Pub	R2	BioSci	52	52.00	3,861	3,861	0.26	BIOL08	0.980	1303.95
North Carolina State University at Raleigh	2972	Pub	R1	BioSci	118	118.00	7,051	7,051	0.27	BIOL08	0.980	1303.95
University of Texas at Dallas	9741	Pub	D2	BioSci	12	12.00	908	908	0.29	BIOL08	0.980	1303.95
University of Michigan at Ann Arbor	9092	Pub	R1	BioSci	236	236.00	18,301	18,301	0.29	BIOL08	0.980	1303.95
University of Texas at Austin	3658	Pub	R1	BioSci	126	126.00	6,911	6,911	0.30	BIOL08	0.980	1303.95
University of Pittsburgh Main Campus	3379	Pub	R1	BioSci	116	116.00	7,063	7,063	0.30	BIOL08	0.980	1303.95
University of California-Davis	1313	Pub	R1	BioSci	387	387.00	4,663	4,663	0.32	BIOL09	0.778	1515.94
University of North Dakota, All Campuses	3005	Pub	D2	BioSci	35	35.00	1,225	1,225	0.32	BIOL09	0.778	1515.94
East Texas State University, All Campuses	3565	Pub	D2	BioSci	0	9.35	1	1	0.35	BIOL09	0.778	1515.94
Southern Illinois University-Carbondale	1758	Pub	R2	BioSci	62	62.00	516	516	0.37	BIOL09	0.778	1515.94
University of Rhode Island	3414	Pub	R2	BioSci	48	48.00	954	954	0.37	BIOL09	0.778	1515.94
SUNY at Binghamton	2836	Pub	D1	BioSci	0	32.46	953	953	0.38	BIOL09	0.778	1515.94
SUNY College of Environmental Science and F	2851	Pub	D2	BioSci	34	34.00	1,537	1,537	0.38	BIOL09	0.778	1515.94
University of Missouri, Kansas City	2518	Pub	D2	BioSci	0	14.42	21	21	0.38	BIOL09	0.778	1515.94
Miami University, All Campuses	7104	Pub	D1	BioSci	45	45.00	144	144	0.38	BIOL09	0.778	1515.94
Colorado State University	1350	Pub	R1	BioSci	126	126.00	8,902	8,902	0.39	BIOL09	0.778	1515.94
Virginia Polytechnic Institute and State Univ	3754	Pub	R1	BioSci	98	98.00	1,552	1,552	0.40	BIOL09	0.778	1515.94
University of Wisconsin-Milwaukee	3896	Pub	D1	BioSci	23	23.00	194	194	0.41	BIOL09	0.778	1515.94
University of Florida	1535	Pub	R1	BioSci	156	156.00	4,043	4,043	0.41	BIOL09	0.778	1515.94
University of Alabama at Birmingham	1052	Pub	D2	BioSci	101	101.00	6,326	6,326	0.42	BIOL09	0.778	1515.94
College of William and Mary	3705	Pub	D1	BioSci	0	19.71	48	48	0.42	BIOL09	0.778	1515.94
University of Nebraska at Lincoln	2565	Pub	R2	BioSci	77	77.00	1,380	1,380	0.43	BIOL09	0.778	1515.94
Indiana State University, Terre Haute	9563	Pub	D2	BioSci	23	23.00	185	185	0.44	BIOL09	0.778	1515.94
Rutgers, the State University at New Brunswick	6964	Pub	R1	BioSci	225	225.00	6,966	6,966	0.44	BIOL09	0.778	1515.94
University of North Carolina at Chapel Hill	2974	Pub	R1	BioSci	227	227.00	13,919	13,919	0.44	BIOL10	0.605	2178.06
University of Louisville	1999	Pub	D1	BioSci	57	57.00	1,345	1,345	0.45	BIOL10	0.605	2178.06
University of Hawaii at Manoa	1610	Pub	R1	BioSci	101	101.00	4,702	4,702	0.46	BIOL10	0.605	2178.06
University of South Dakota	3474	Pub	D2	BioSci	14	14.00	207	207	0.46	BIOL10	0.605	2178.06
Iowa State University	1869	Pub	R2	BioSci	133	133.00	6,635	6,635	0.46	BIOL10	0.605	2178.06
New Mexico State University, All Campuses	2657	Pub	R1	BioSci	26	26.00	348	348	0.50	BIOL10	0.605	2178.06
University of California-San Francisco	1319	Pub	R1	BioSci	109	109.00	0	118	0.50	BIOL10	0.605	2178.06
SUNY at Buffalo, Main Campus	2837	Pub	R2	BioSci	158	158.00	7,777	7,777	0.50	BIOL10	0.605	2178.06
University of Kentucky, Main Campus	1989	Pub	R1	BioSci	101	101.00	662	662	0.53	BIOL10	0.605	2178.06
Bowling Green State University, All Campuses	3018	Pub	D1	BioSci	29	29.00	244	244	0.55	BIOL10	0.605	2178.06

Table 5-A.2: Segmentation Array: Biological Sciences

School	FICE	TOC	Carnegie Class	Academic Discipline	Faculty	Faculty (adjusted)	R&D Expenditures	R&D Exp (adjusted)	Factor Score	Segment	Segment RU Fraction	Segment Faculty
Cleveland State University	3032	Pub	D2	BioSci	0	15.41	74	74	0.58	BIOL10	0.605	2178.06
University of Oregon	3223	Pub	R2	BioSci	78	78.00	1,493	1,493	0.62	BIOL10	0.605	2178.06
University of Akron, All Campuses	3123	Pub	D1	BioSci	0	20.63	147	147	0.63	BIOL10	0.605	2178.06
University of Oklahoma, Norman Campus	3184	Pub	R2	BioSci	102	102.00	3,692	3,692	0.63	BIOL10	0.605	2178.06
Georgia State University	1574	Pub	D1	BioSci	0	14.59	258	258	0.65	BIOL10	0.605	2178.06
University of Arkansas, Main Campus	1108	Pub	D1	BioSci	0	50.38	387	387	0.65	BIOL10	0.605	2178.06
Northern Arizona University	1082	Pub	D2	BioSci	0	26.67	299	299	0.66	BIOL10	0.605	2178.06
Tennessee Technological University	3523	Pub	D2	BioSci	0	16.58	214	214	0.67	BIOL10	0.605	2178.06
Old Dominion University	3728	Pub	D2	BioSci	0	44.02	185	185	0.68	BIOL10	0.605	2178.06
Auburn University, Main Campus	1009	Pub	R2	BioSci	70	70.00	0	77	0.69	BIOL10	0.605	2178.06
University of Northern Colorado	1349	Pub	D1	BioSci	0	11.93	0	12	0.70	BIOL10	0.605	2178.06
University of South Carolina at Columbia	3448	Pub	R2	BioSci	0	75.51	548	548	0.70	BIOL10	0.605	2178.06
University of Nevada-Reno	2568	Pub	D2	BioSci	0	39.16	256	256	0.75	BIOL10	0.605	2178.06
Middle Tennesse State University	3510	Pub	D2	BioSci	0	16.82	0	17	0.76	BIOL10	0.605	2178.06
Florida Atlantic University	1481	Pub	D2	BioSci	0	13.60	75	75	0.76	BIOL10	0.605	2178.06
Oklahoma State University, All Campuses	3170	Pub	R2	BioSci	115	115.00	3,264	3,264	0.77	BIOL10	0.605	2178.06
Illinois State University	1692	Pub	D2	BioSci	0	33.57	150	150	0.77	BIOL10	0.605	2178.06
University of Texas at Arlington	3656	Pub	D2	BioSci	0	21.10	32	32	0.78	BIOL10	0.605	2178.06
University of Alabama	1051	Pub	D1	BioSci	0	26.94	210	210	0.79	BIOL10	0.605	2178.06
Memphis State University	3509	Pub	D1	BioSci	0	27.37	258	258	0.79	BIOL10	0.605	2178.06
University of Missouri, Saint Louis	2519	Pub	D2	BioSci	0	19.13	108	108	0.81	BIOL10	0.605	2178.06
Portland State University	3216	Pub	D2	BioSci	0	21.42	25	25	0.81	BIOL10	0.605	2178.06
Ball State University	1766	Pub	D1	BioSci	0	34.80	30	30	0.82	BIOL10	0.605	2178.06
University of Maryland Baltimore County	2105	Pub	D2	BioSci	0	34.19	779	779	0.86	BIOL10	0.605	2178.06
University of Toledo	3131	Pub	D1	BioSci	0	34.73	19	19	0.87	BIOL10	0.605	2178.06
University of North Carolina at Greensboro	2976	Pub	D2	BioSci	0	22.19	3	3	0.88	BIOL10	0.605	2178.06
Louisiana Tech University	2008	Pub	D2	BioSci	0	25.94	244	244	0.92	BIOL10	0.605	2178.06
University of Missouri, Rolla	2517	Pub	D2	BioSci	0	2.94	0	3	0.93	BIOL10	0.605	2178.06
University of New Orleans	2015	Pub	D2	BioSci	0	40.32	1,788	1,788	0.98	BIOL10	0.605	2178.06
Georgia Institute of Technology, Main Campus	1569	Pub	R1	BioSci	0	22.13	588	588	1.06	BIOL10	0.605	2178.06
Colorado School of Mines	1348	Pub	D2	BioSci	0	0.00	0	0	•	BIOL10	0.605	2178.06
Louisiana State University and Agric & Mech Cc	2010	Pub	R1	BioSci	0	0.00	0	0	•	BIOL10	0.605	2178.06
CUNY Graduate School and University Center	4063	Pub	D1	BioSci	146	146.00	0	0	•	BIOL10	0.605	2178.06

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Table 5-A.3: Segmentation Array: Chemistry

School	FICE	TOC	Carnegie Class	Academic Discipline	Faculty	Faculty (adjusted)	R&D Expenditures	R&D Exp (adjusted)	Factor Score	Segment	Segment RU Fraction	Segment Faculty
Columbia University, Main Campus	2707	Pri	R1	Chemistry	17	17.00	4,437	4,437	-3.81	CHEM01	1.000	179.00
Stanford University	1305	Pri	R1	Chemistry	18	18.00	4,788	4,788	-3.69	CHEM01	1.000	179.00
Harvard University	2155	Pri	R1	Chemistry	24	24.00	4,797	4,797	-3.29	CHEM01	1.000	179.00
California Institute of Technology	1131	Pri	R1	Chemistry	27	27.00	6,328	6,328	-2.78	CHEM01	1.000	179.00
Cornell University, All Campuses	2711	Pri	R1	Chemistry	29	29.00	3,808	3,808	-2.44	CHEM01	1.000	179.00
Princeton University	2627	Pri	R1	Chemistry	17	17.00	2,065	2,065	-2.17	CHEM01	1.000	179.00
Case Western Reserve University	3024	Pri	R1	Chemistry	19	19.00	1938	1938	-1.79	CHEM01	1.000	179.00
Northwestern University	1739	Pri	R1	Chemistry	28	28.00	2,367	2,367	-1.66	CHEM01	1.000	179.00
University of Chicago	1774	Pri	R1	Chemistry	28	28.00	3,958	3,958	-1.56	CHEM02	0.883	247.00
Massachusetts Institute of Technology	2178	Pri	R1	Chemistry	53	53.00	6,764	6,764	-1.31	CHEM02	0.883	247.00
University of Pennsylvania	3378	Pri	R1	Chemistry	25	25.00	3,688	3,688	-1.28	CHEM02	0.883	247.00
University of Notre Dame	1840	Pri	D1	Chemistry	16	16.00	3,457	3,457	-1.28	CHEM02	0.883	247.00
Yale University	1426	Pri	R1	Chemistry	24	24.00	2,023	2,023	-1.14	CHEM02	0.883	247.00
Duke University	2920	Pri	R1	Chemistry	22	22.00	878	878	-1.06	CHEM02	0.883	247.00
University of Southern California	1328	Pri	R1	Chemistry	26	26.00	2,313	2,313	-1.05	CHEM02	0.883	247.00
Johns Hopkins University	2077	Pri	R1	Chemistry	18	18.00	1,586	1,586	-0.96	CHEM02	0.883	247.00
University of Rochester	2894	Pri	R1	Chemistry	22	22.00	2,089	2,089	-0.90	CHEM02	0.883	247.00
Northeastern University	2199	Pri	D2	Chemistry	13	13.00	671	671	-0.40	CHEM02	0.883	247.00
Polytechnic University	2796	Pri	D2	Chemistry	18	18.00	769	769	-0.39	CHEM03	0.436	742.92
American University	1434	Pri	D1	Chemistry	11	11.00	330	330	-0.36	CHEM03	0.436	742.92
Brown University	3401	Pri	R2	Chemistry	23	23.00	1,200	1,200	-0.36	CHEM03	0.436	742.92
Emory University	1564	Pri	R2	Chemistry	16	16.00	705	705	-0.29	CHEM03	0.436	742.92
Carnegie Mellon University	3242	Pri	R1	Chemistry	22	22.00	2,075	2,075	-0.26	CHEM03	0.436	742.92
Clark Atlanta University	1559	Pri	D2	Chemistry	8	8.00	867	867	-0.12	CHEM03	0.436	742.92
Syracuse University, Main Campus	2882	Pri	R2	Chemistry	18	18.00	764	764	-0.12	CHEM03	0.436	742.92
Duquesne University	3258	Pri	D2	Chemistry	0	8.19	172	172	-0.10	CHEM03	0.436	742.92
University of Denver	1371	Pri	D1	Chemistry	13	13.00	1,007	1,007	-0.10	CHEM03	0.436	742.92
Brandeis University	2133	Pri	R2	Chemistry	18	18.00	832	832	-0.08	CHEM03	0.436	742.92
Georgetown University	1445	Pri	R2	Chemistry	14	14.00	845	845	0.04	CHEM03	0.436	742.92
Howard University	1448	Pri	R1	Chemistry	20	20.00	1,287	1,287	0.04	CHEM03	0.436	742.92
Rensselaer Polytechnic Institute	2803	Pri	R2	Chemistry	30	30.00	1,551	1,551	0.05	CHEM03	0.436	742.92
New York University	2785	Pri	R1	Chemistry	27	27.00	943	943	0.11	CHEM03	0.436	742.92
Lehigh University	3289	Pri	D1	Chemistry	0	18.74	1,066	1,066	0.12	CHEM03	0.436	742.92
Fordham University	2722	Pri	D1	Chemistry	0	14.25	156	156	0.13	CHEM03	0.436	742.92
Vanderbilt University	3535	Pri	R1	Chemistry	19	19.00	505	505	0.14	CHEM03	0.436	742.92
Washington University	2520	Pri	R1	Chemistry	19	19.00	957	957	0.14	CHEM03	0.436	742.92
Dartmouth College	2573	Pri	D2	Chemistry	0	16.69	542	542	0.16	CHEM03	0.436	742.92
Catholic University of America	1437	Pri	D1	Chemistry	12	12.00	576	576	0.20	CHEM03	0.436	742.92
Rice University	3604	Pri	D1	Chemistry	19	19.00	1,310	1,310	0.20	CHEM03	0.436	742.92
Drexel University	3256	Pri	D2	Chemistry	15	15.00	731	731	0.22	CHEM03	0.436	742.92
Clarkson University	2699	Pri	D2	Chemistry	15	15.00	1,157	1,157	0.26	CHEM03	0.436	742.92
Baylor University	6967	Pri	D2	Chemistry	12	12.00	260	260	0.29	CHEM03	0.436	742.92
Texas Christian University	3636	Pri	D2	Chemistry	0	10.91	407	407	0.30	CHEM03	0.436	742.92
Marquette University	3863	Pri	D1	Chemistry	0	13.44	122	122	0.31	CHEM03	0.436	742.92

Table 5-A.3: Segmentation Array: Chemistry

School	FICE	TOC	Carnegie Class	Academic Discipline	Faculty	Faculty (adjusted)	R&D Expenditures	R&D Exp (adjusted)	Factor Score	Segment	Segment RU Fraction	Segment Faculty
Boston College	2128	Pri	D1	Chemistry	19	19.00	624	624	0.45	CHEM03	0.436	742.92
Saint Louis University, Main Campus	2506	Pri	D1	Chemistry	0	8.58	1	1	0.45	CHEM03	0.436	742.92
Tufts University	2219	Pri	D1	Chemistry	0	10.91	63	63	0.49	CHEM03	0.436	742.92
Rockefeller University	2807	Pri	R1	Chemistry	0	10.91	1,170	1,170	0.49	CHEM03	0.436	742.92
Boston University	2130	Pri	R1	Chemistry	22	22.00	711	711	0.52	CHEM03	0.436	742.92
Illinois Institute of Technology	1691	Pri	D1	Chemistry	15	15.00	531	531	0.56	CHEM03	0.436	742.92
University of Miami	1536	Pri	R1	Chemistry	16	16.00	83	83	0.59	CHEM03	0.436	742.92
Brigham Young University, Main Campus	3670	Pri	D1	Chemistry	21	21.00	837	837	0.61	CHEM03	0.436	742.92
Tulane University of Louisiana	2029	Pri	R2	Chemistry	12	12.00	74	74	0.62	CHEM03	0.436	742.92
Stevens Institute of Technology	2639	Pri	D2	Chemistry	0	13.37	176	176	0.76	CHEM03	0.436	742.92
George Washington University	1444	Pri	R2	Chemistry	0	13.60	359	359	0.86	CHEM03	0.436	742.92
Loyola University of Chicago	1710	Pri	D1	Chemistry	17	17.00	42	42	0.89	CHEM03	0.436	742.92
Southern Methodist University	3613	Pri	D2	Chemistry	0	6.81	58	58	0.95	CHEM03	0.436	742.92
Adelphi University	2666	Pri	D2	Chemistry	0	13.31	54	54	1.00	CHEM03	0.436	742.92
Saint John's University New York	2823	Pri	D1	Chemistry	0	9.78	0	10	1.01	CHEM03	0.436	742.92
University of San Francisco	1325	Pri	D2	Chemistry	0	7.44	91	91	1.04	CHEM03	0.436	742.92
Clark University	2139	Pri	D2	Chemistry	9	9.00	0	5	1.06	CHEM03	0.436	742.92
Andrews University	2238	Pri	D2	Chemistry	0	5.91	2	2	1.10	CHEM03	0.436	742.92
Yeshiva University	2903	Pri	R1	Chemistry	0	23.35	0	23	1.17	CHEM03	0.436	742.92
Drake University	1860	Pri	D2	Chemistry	0	5.91	3	3	1.24	CHEM03	0.436	742.92
University of Tulsa	3185	Pri	D2	Chemistry	0	6.68	0	7	1.27	CHEM03	0.436	742.92
Hofstra University	2732	Pri	D2	Chemistry	0	10.03	22	22	1.28	CHEM03	0.436	742.92
Loma Linda University	1218	Pri	D2	Chemistry	0	17.65	0	18	1.28	CHEM03	0.436	742.92
Florida Institute of Technology	1469	Pri	D2	Chemistry	0	9.91	0	10	1.29	CHEM03	0.436	742.92
Pepperdine University	1264	Pri	D2	Chemistry	0	1.90	0	2	1.32	CHEM03	0.436	742.92
Hahnemann University	3271	Pri	D2	Chemistry	0	2.78	0	3	1.36	CHEM03	0.436	742.92
Biola University	1122	Pri	D2	Chemistry	0	1.87	0	2	1.38	CHEM03	0.436	742.92
Claremont Univ Center & Graduate School	1169	Pri	D1	Chemistry	0	0.00	0 •		•	CHEM03	0.436	742.92
Columbia University, Teachers College	3979	Pri	D1	Chemistry	0	0.00	0 •		•	CHEM03	0.436	742.92
New School For Social Research	2780	Pri	D2	Chemistry	0	0.00	0 •		•	CHEM03	0.436	742.92
Nova University	1509	Pri	D1	Chemistry	0	0.00	0 •		•	CHEM03	0.436	742.92
Union Institute	10923	Pri	D1	Chemistry	0	0.00	0 •		•	CHEM03	0.436	742.92
University of California-Berkeley	1312	Pub	R1	Chemistry	48	48.00	6,022	6,022	-3.28	CHEM04	1.000	155.00
University of Illinois at Urbana-Champaign	1775	Pub	R1	Chemistry	43	43.00	4,261	4,261	-2.14	CHEM04	1.000	155.00
Pennsylvania State U, Main Campus	6965	Pub	R1	Chemistry	25	25.00	2,973	2,973	-2.11	CHEM04	1.000	155.00
University of Wisconsin-Madison	3895	Pub	R1	Chemistry	39	39.00	3,976	3,976	-1.97	CHEM04	1.000	155.00
University of Pittsburgh Main Campus	3379	Pub	R1	Chemistry	23	23.00	1,641	1,641	-1.85	CHEM05	1.000	193.00
Purdue University, Main Campus	1825	Pub	R1	Chemistry	47	47.00	3,596	3,596	-1.78	CHEM05	1.000	193.00
University of Massachusetts at Amherst	2221	Pub	R2	Chemistry	23	23.00	1,889	1,889	-1.76	CHEM05	1.000	193.00
University of Texas at Austin	3658	Pub	R1	Chemistry	36	36.00	3,970	3,970	-1.76	CHEM05	1.000	193.00
SUNY at Buffalo, Main Campus	2837	Pub	R2	Chemistry	25	25.00	1,665	1,665	-1.53	CHEM05	1.000	193.00
Ohio State University, Main Campus	6883	Pub	R1	Chemistry	39	39.00	2,654	2,654	-1.45	CHEM05	1.000	193.00
University of California-San Diego	1317	Pub	R1	Chemistry	31	31.00	4,425	4,425	-1.37	CHEM06	0.948	248.00
University of California-Los Angeles	1315	Pub	R1	Chemistry	43	43.00	4,159	4,159	-1.37	CHEM06	0.948	248.00

Table 5-A.3: Segmentation Array: Chemistry

School	FICE	TOC	Carnegie Class	Academic Discipline	Faculty	Faculty (adjusted)	R&D Expenditures	R&D Exp (adjusted)	Factor Score	Segment	Segment RU Fraction	Segment Faculty
University of Utah	3675	Pub	R1	Chemistry	27	27.00	2,811	2,811	-1.29	CHEM06	0.948	248.00
Georgia Institute of Technology, Main Campus	1569	Pub	R1	Chemistry	24	24.00	3,655	3,655	-1.22	CHEM06	0.948	248.00
Indiana University at Bloomington	1809	Pub	R1	Chemistry	36	36.00	3,147	3,147	-1.17	CHEM06	0.948	248.00
University of Illinois at Chicago	1776	Pub	R1	Chemistry	20	20.00	764	764	-1.17	CHEM06	0.948	248.00
Iowa State University	1869	Pub	R2	Chemistry	33	33.00	1,159	1,159	-1.05	CHEM06	0.948	248.00
University of Georgia	1598	Pub	R1	Chemistry	21	21.00	1,202	1,202	-0.97	CHEM06	0.948	248.00
Texas Tech University	3644	Pub	D1	Chemistry	13	13.00	757	757	-0.85	CHEM06	0.948	248.00
University of North Carolina at Chapel Hill	2974	Pub	R1	Chemistry	30	30.00	1,789	1,789	-0.83	CHEM07	1.000	315.00
University of California-Irvine	1314	Pub	R1	Chemistry	20	20.00	1,398	1,398	-0.77	CHEM07	1.000	315.00
University of Delaware	1431	Pub	R2	Chemistry	18	18.00	1,158	1,158	-0.62	CHEM07	1.000	315.00
University of Michigan at Ann Arbor	9092	Pub	R1	Chemistry	43	43.00	2,064	2,064	-0.62	CHEM07	1.000	315.00
University of California-Santa Barbara	1320	Pub	R2	Chemistry	26	26.00	1,434	1,434	-0.61	CHEM07	1.000	315.00
University of South Carolina at Columbia	3448	Pub	R2	Chemistry	25	25.00	970	970	-0.60	CHEM07	1.000	315.00
Texas A & M University, Main Campus	10366	Pub	R1	Chemistry	46	46.00	4,097	4,097	-0.58	CHEM07	1.000	315.00
University of Nebraska at Lincoln	2565	Pub	R2	Chemistry	25	25.00	2,289	2,289	-0.54	CHEM07	1.000	315.00
University of Florida	1535	Pub	R1	Chemistry	35	35.00	2,283	2,283	-0.54	CHEM07	1.000	315.00
University of Minnesota at Twin Cities	3969	Pub	R1	Chemistry	47	47.00	2,642	2,642	-0.51	CHEM07	1.000	315.00
Michigan State University	2290	Pub	R1	Chemistry	40	40.00	1,638	1,638	-0.51	CHEM08	0.905	398.00
University of Arizona	1083	Pub	R1	Chemistry	28	28.00	1,380	1,380	-0.46	CHEM08	0.905	398.00
University of Houston-University Park	3652	Pub	D1	Chemistry	23	23.00	1,371	1,371	-0.39	CHEM08	0.905	398.00
University of Kansas, Main Campus	1948	Pub	R2	Chemistry	29	29.00	1,329	1,329	-0.36	CHEM08	0.905	398.00
University of Cincinnati, All Campuses	3125	Pub	R1	Chemistry	29	29.00	633	633	-0.31	CHEM08	0.905	398.00
University of Washington	3798	Pub	R1	Chemistry	34	34.00	1,326	1,326	-0.28	CHEM08	0.905	398.00
University of Oregon	3223	Pub	R2	Chemistry	23	23.00	1,119	1,119	-0.28	CHEM08	0.905	398.00
Oregon State University	3210	Pub	R1	Chemistry	25	25.00	1,068	1,068	-0.24	CHEM08	0.905	398.00
Oklahoma State University, All Campuses	3170	Pub	R2	Chemistry	17	17.00	769	769	-0.23	CHEM08	0.905	398.00
Wayne State University	2329	Pub	R2	Chemistry	30	30.00	2,163	2,163	-0.21	CHEM08	0.905	398.00
Colorado State University	1350	Pub	R1	Chemistry	24	24.00	1,973	1,973	-0.21	CHEM08	0.905	398.00
SUNY at Stony Brook, All Campuses	2838	Pub	R1	Chemistry	32	32.00	1,966	1,966	-0.19	CHEM08	0.905	398.00
University of Virginia, Main Campus	6968	Pub	R1	Chemistry	26	26.00	1,203	1,203	-0.18	CHEM08	0.905	398.00
University of New Hampshire, Main Campus	2589	Pub	D2	Chemistry	15	15.00	221	221	-0.16	CHEM08	0.905	398.00
University of Iowa	1892	Pub	R1	Chemistry	23	23.00	1,488	1,488	-0.15	CHEM08	0.905	398.00
Kansas State University of Agriculture and App	1928	Pub	R2	Chemistry	18	18.00	672	672	-0.15	CHEM09	0.684	457.95
West Virginia University	3827	Pub	R2	Chemistry	0	13.91	250	250	-0.14	CHEM09	0.684	457.95
University of Vermont	3696	Pub	D2	Chemistry	13	13.00	597	597	-0.11	CHEM09	0.684	457.95
University of California-Santa Cruz	1321	Pub	D1	Chemistry	12	12.00	900	900	-0.08	CHEM09	0.684	457.95
Arizona State University	1081	Pub	R2	Chemistry	24	24.00	1,449	1,449	-0.07	CHEM09	0.684	457.95
University of North Texas	3594	Pub	D1	Chemistry	18	18.00	528	528	-0.06	CHEM09	0.684	457.95
Florida State University	1489	Pub	R2	Chemistry	31	31.00	2,791	2,791	0.00	CHEM09	0.684	457.95
University of California-Riverside	1316	Pub	D1	Chemistry	18	18.00	637	637	0.03	CHEM09	0.684	457.95
North Carolina State University at Raleigh	2972	Pub	R1	Chemistry	26	26.00	216	216	0.06	CHEM09	0.684	457.95
University of Hawaii at Manoa	1610	Pub	R1	Chemistry	17	17.00	622	622	0.06	CHEM09	0.684	457.95
University of Missouri, Kansas City	2518	Pub	D2	Chemistry	16	16.00	301	301	0.07	CHEM09	0.684	457.95
Virginia Polytechnic Institute and State Univ	3754	Pub	R1	Chemistry	30	30.00	1,612	1,612	0.08	CHEM09	0.684	457.95

Table 5-A.3: Segmentation Array: Chemistry

School	FICE	TCC	Carnegie Class	Academic Discipline	Faculty	Faculty (adjusted)	R&D Expenditures	R&D Exp (adjusted)	Factor Score	Segment	Segment RU Fraction	Segment Faculty
University of California-San Francisco	1319	Pub	R1	Chemistry	0	24.15	1,564	1,564	0.11	CHEM09	0.684	457.95
Cleveland State University	3032	Pub	D2	Chemistry	0	11.44	100	100	0.11	CHEM09	0.684	457.95
University of Wisconsin-Milwaukee	3896	Pub	D1	Chemistry	17	17.00	672	672	0.13	CHEM09	0.684	457.95
University of California-Davis	1313	Pub	R1	Chemistry	32	32.00	1,290	1,290	0.15	CHEM09	0.684	457.95
SUNY at Binghamton	2836	Pub	D1	Chemistry	16	16.00	643	643	0.18	CHEM09	0.684	457.95
University of Tennessee at Knoxville	3530	Pub	R1	Chemistry	28	28.00	0	25	0.18	CHEM09	0.684	457.95
University of Idaho	1626	Pub	D2	Chemistry	12	12.00	388	388	0.21	CHEM09	0.684	457.95
University of Rhode Island	3414	Pub	R2	Chemistry	15	15.00	339	339	0.21	CHEM09	0.684	457.95
University of Maryland at College Park	2103	Pub	R1	Chemistry	54	54.00	2,766	2,766	0.21	CHEM09	0.684	457.95
University of Nevada-Reno	2568	Pub	D2	Chemistry	0	11.44	227	227	0.21	CHEM09	0.684	457.95
University of Colorado at Boulder	1370	Pub	R1	Chemistry	53	53.00	3,332	3,332	0.21	CHEM10	0.343	1141.88
University of Mississippi, Main Campus	2440	Pub	D1	Chemistry	0	10.35	165	165	0.25	CHEM10	0.343	1141.88
Ohio University, All Campuses	3100	Pub	D1	Chemistry	16	16.00	398	398	0.26	CHEM10	0.343	1141.88
Virginia Commonwealth University	3735	Pub	R2	Chemistry	0	8.58	267	267	0.27	CHEM10	0.343	1141.88
Temple University	3371	Pub	R2	Chemistry	18	18.00	360	360	0.27	CHEM10	0.343	1141.88
University of Alabama	1051	Pub	D1	Chemistry	16	16.00	247	247	0.30	CHEM10	0.343	1141.88
University of Southern Mississippi	2441	Pub	D1	Chemistry	14	14.00	566	566	0.31	CHEM10	0.343	1141.88
University of Akron, All Campuses	3123	Pub	D1	Chemistry	28	28.00	712	712	0.32	CHEM10	0.343	1141.88
Northern Illinois University	1737	Pub	D1	Chemistry	21	21.00	540	540	0.32	CHEM10	0.343	1141.88
SUNY at Albany	2835	Pub	R2	Chemistry	0	19.27	739	739	0.35	CHEM10	0.343	1141.88
Southern Illinois University-Carbondale	1758	Pub	R2	Chemistry	16	16.00	245	245	0.36	CHEM10	0.343	1141.88
Washington State University	3800	Pub	R2	Chemistry	29	29.00	1,043	1,043	0.36	CHEM10	0.343	1141.88
University of New Orleans	2015	Pub	D2	Chemistry	19	19.00	521	521	0.37	CHEM10	0.343	1141.88
University of Louisville	1999	Pub	D1	Chemistry	17	17.00	425	425	0.38	CHEM10	0.343	1141.88
University of South Florida	1537	Pub	D1	Chemistry	17	17.00	245	245	0.38	CHEM10	0.343	1141.88
University of Arkansas, Main Campus	1108	Pub	D1	Chemistry	22	22.00	1,674	1,674	0.39	CHEM10	0.343	1141.88
SUNY College of Environmental Science and F	2851	Pub	D2	Chemistry	14	14.00	640	640	0.42	CHEM10	0.343	1141.88
University of Missouri, Saint Louis	2519	Pub	D2	Chemistry	0	13.71	118	118	0.44	CHEM10	0.343	1141.88
University of Connecticut, Main Campus	29013	Pub	R1	Chemistry	28	28.00	1,300	1,300	0.45	CHEM10	0.343	1141.88
New Mexico State University, All Campuses	2657	Pub	R1	Chemistry	0	18.01	531	531	0.46	CHEM10	0.343	1141.88
University of Kentucky, Main Campus	1989	Pub	R1	Chemistry	24	24.00	202	202	0.49	CHEM10	0.343	1141.88
Auburn University, Main Campus	1009	Pub	R2	Chemistry	17	17.00	420	420	0.50	CHEM10	0.343	1141.88
North Dakota State University, All Campuses	9265	Pub	D2	Chemistry	14	14.00	310	310	0.50	CHEM10	0.343	1141.88
University of Oklahoma, Norman Campus	3184	Pub	R2	Chemistry	26	26.00	1,275	1,275	0.50	CHEM10	0.343	1141.88
University of Missouri, Columbia	2516	Pub	R1	Chemistry	16	16.00	354	354	0.51	CHEM10	0.343	1141.88
Clemson University	3425	Pub	D1	Chemistry	17	17.00	347	347	0.52	CHEM10	0.343	1141.88
University of Northern Colorado	1349	Pub	D1	Chemistry	0	7.30	0	7	0.55	CHEM10	0.343	1141.88
University of New Mexico, All Campuses	10313	Pub	R1	Chemistry	17	17.00	225	225	0.56	CHEM10	0.343	1141.88
Miami University, All Campuses	7104	Pub	D1	Chemistry	0	19.27	251	251	0.56	CHEM10	0.343	1141.88
Mississippi State University	2423	Pub	R2	Chemistry	0	13.44	93	93	0.67	CHEM10	0.343	1141.88
Rutgers, the State University at New Brunswick	6964	Pub	R1	Chemistry	56	56.00	1,406	1,406	0.67	CHEM10	0.343	1141.88
East Texas State University, All Campuses	3565	Pub	D2	Chemistry	0	5.18	79	79	0.72	CHEM10	0.343	1141.88
University of Wyoming	3932	Pub	R2	Chemistry	16	16.00	207	207	0.73	CHEM10	0.343	1141.88
Montana State University	2532	Pub	D2	Chemistry	21	21.00	646	646	0.74	CHEM10	0.343	1141.88

Table 5-A.3: Segmentation Array: Chemistry

School	FICE	TOC	Carnegie Class	Academic Discipline	Faculty	Faculty (adjusted)	R&D Expenditures	R&D Exp (adjusted)	Factor Score	Segment	Segment RU Fraction	Segment Faculty
Kent State University, All Campuses	3051	Pub	D1	Chemistry	24	24.00	275	275	0.79	CHEM10	0.343	1141.88
Utah State University	3677	Pub	R2	Chemistry	16	16.00	461	461	0.82	CHEM10	0.343	1141.88
University of North Dakota, All Campuses	3005	Pub	D2	Chemistry	15	15.00	317	317	0.83	CHEM10	0.343	1141.88
Illinois State University	1692	Pub	D2	Chemistry	0	15.54	168	168	0.87	CHEM10	0.343	1141.88
Western Michigan University	2330	Pub	D1	Chemistry	17	17.00	37	37	0.87	CHEM10	0.343	1141.88
College of William and Mary	3705	Pub	D1	Chemistry	0	9.19	49	49	0.87	CHEM10	0.343	1141.88
University of Toledo	3131	Pub	D1	Chemistry	0	16.87	187	187	0.88	CHEM10	0.343	1141.88
Bowling Green State University, All Campuses	3018	Pub	D1	Chemistry	0	13.08	125	125	0.90	CHEM10	0.343	1141.88
University of Alabama at Birmingham	1052	Pub	D2	Chemistry	0	10.35	20	20	0.91	CHEM10	0.343	1141.88
Memphis State University	3509	Pub	D1	Chemistry	0	15.54	109	109	0.94	CHEM10	0.343	1141.88
University of Texas at Dallas	9741	Pub	D2	Chemistry	0	8.47	235	235	0.94	CHEM10	0.343	1141.88
Florida Atlantic University	1481	Pub	D2	Chemistry	0	8.93	75	75	0.94	CHEM10	0.343	1141.88
University of Texas at Arlington	3656	Pub	D2	Chemistry	0	20.93	276	276	0.96	CHEM10	0.343	1141.88
Middle Tennesse State University	3510	Pub	D2	Chemistry	0	10.91	0	11	0.97	CHEM10	0.343	1141.88
University of Maine at Orono	2053	Pub	D2	Chemistry	0	14.10	179	179	0.97	CHEM10	0.343	1141.88
University of Montana	2536	Pub	D1	Chemistry	0	13.86	143	143	0.99	CHEM10	0.343	1141.88
Ball State University	1786	Pub	D1	Chemistry	0	10.35	17	17	0.99	CHEM10	0.343	1141.88
University of South Dakota	3474	Pub	D2	Chemistry	0	8.19	5	5	1.01	CHEM10	0.343	1141.88
Indiana State University, Terre Haute	9563	Pub	D2	Chemistry	0	9.78	35	35	1.07	CHEM10	0.343	1141.88
Northern Arizona University	1082	Pub	D2	Chemistry	0	10.22	38	38	1.07	CHEM10	0.343	1141.88
University of Missouri, Rolla	2517	Pub	D2	Chemistry	23	23.00	300	300	1.07	CHEM10	0.343	1141.88
Old Dominion University	3728	Pub	D2	Chemistry	0	18.43	138	138	1.08	CHEM10	0.343	1141.88
Colorado School of Mines	1348	Pub	D2	Chemistry	0	15.22	0	15	1.09	CHEM10	0.343	1141.88
Tennessee Technological University	3523	Pub	D2	Chemistry	0	10.21	43	43	1.09	CHEM10	0.343	1141.88
University of North Carolina at Greensboro	2976	Pub	D2	Chemistry	0	11.25	25	25	1.13	CHEM10	0.343	1141.88
University of Maryland Baltimore County	2105	Pub	D2	Chemistry	0	18.11	552	552	1.13	CHEM10	0.343	1141.88
Texas Woman's University	3646	Pub	D1	Chemistry	0	9.19	80	80	1.13	CHEM10	0.343	1141.88
Louisiana Tech University	2008	Pub	D2	Chemistry	0	7.30	21	21	1.13	CHEM10	0.343	1141.88
Portland State University	3216	Pub	D2	Chemistry	0	16.44	110	110	1.14	CHEM10	0.343	1141.88
Georgia State University	1574	Pub	D1	Chemistry	0	13.08	96	96	1.14	CHEM10	0.343	1141.88
Idaho State University	1620	Pub	D2	Chemistry	0	8.19	2	2	1.20	CHEM10	0.343	1141.88
CUNY Graduate School and University Center	4063	Pub	D1	Chemistry	56	56.00	0	•		• CHEM10	0.343	1141.88
Louisiana State University and Agric & Mech Co	2010	Pub	R1	Chemistry	0	0.00	0	•		• CHEM10	0.343	1141.88

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Table 5-A.4: Segmentation Array: GeoSciences

School	FICE	TOC	Carnegie Class	Academic Discipline	Faculty	Faculty (adjusted)	R&D Expenditures	R&D Exp (adjusted)	Factor Score	Segment	Segment RU Fraction	Segment Faculty
Rice University	3604	Pri	D1	GEOSCI	11	11.00	603	603	-1.73	GEOS01	0.858	113.00
University of Miami	1536	Pri	R1	GEOSCI	17	17.00	12,491	12,491	-1.55	GEOS01	0.858	113.00
Saint Louis University, Main Campus	2506	Pri	D1	GEOSCI	5	5.00	672	672	-1.22	GEOS01	0.858	113.00
Harvard University	2155	Pri	R1	GEOSCI	13	13.00	5,548	5,548	-1.16	GEOS01	0.858	113.00
Johns Hopkins University	2077	Pri	R1	GEOSCI	11	11.00	5,871	5,871	-1.09	GEOS01	0.858	113.00
Columbia University, Main Campus	2707	Pri	R1	GEOSCI	28	28.00	17,886	17,886	-0.82	GEOS01	0.858	113.00
California Institute of Technology	1131	Pri	R1	GEOSCI	28	28.00	7,266	7,266	-0.75	GEOS01	0.858	113.00
Massachusetts Institute of Technology	2178	Pri	R1	GEOSCI	53	53.00	8,912	8,912	-0.60	GEOS02	1.000	144.00
Brown University	3401	Pri	R2	GEOSCI	16	16.00	2,100	2,100	-0.43	GEOS02	1.000	144.00
Stanford University	1305	Pri	R1	GEOSCI	62	62.00	2,313	2,313	-0.26	GEOS02	1.000	144.00
University of Southern California	1328	Pri	R1	GEOSCI	13	13.00	6,601	6,601	-0.22	GEOS02	1.000	144.00
Dartmouth College	2573	Pri	D2	GEOSCI	0	8.56	302	302	-0.15	GEOS03	0.631	401.21
Cornell University, All Campuses	2711	Pri	R1	GEOSCI	18	18.00	3,363	3,363	-0.14	GEOS03	0.631	401.21
University of Chicago	1774	Pri	R1	GEOSCI	20	20.00	2,159	2,159	-0.07	GEOS03	0.631	401.21
Brigham Young University, Main Campus	3670	Pri	D1	GEOSCI	0	8.28	0	8	-0.06	GEOS03	0.631	401.21
Rensselaer Polytechnic Institute	2803	Pri	R2	GEOSCI	7	7.00	0	8	-0.06	GEOS03	0.631	401.21
Southern Methodist University	3613	Pri	D2	GEOSCI	10	10.00	674	674	0.10	GEOS03	0.631	401.21
Yale University	1426	Pri	R1	GEOSCI	23	23.00	733	733	0.11	GEOS03	0.631	401.21
Syracuse University, Main Campus	2882	Pri	R2	GEOSCI	9	9.00	274	274	0.13	GEOS03	0.631	401.21
Florida Institute of Technology	1469	Pri	D2	GEOSCI	0	15.72	239	239	0.17	GEOS03	0.631	401.21
George Washington University	1444	Pri	R2	GEOSCI	10	10.00	581	581	0.20	GEOS03	0.631	401.21
University of Pennsylvania	3378	Pri	R1	GEOSCI	0	5.50	665	665	0.27	GEOS03	0.631	401.21
Washington University	2520	Pri	R1	GEOSCI	12	12.00	693	693	0.28	GEOS03	0.631	401.21
Duke University	2920	Pri	R1	GEOSCI	0	12.94	1,000	1,000	0.28	GEOS03	0.631	401.21
Lehigh University	3289	Pri	D1	GEOSCI	9	9.00	461	461	0.29	GEOS03	0.631	401.21
Princeton University	2627	Pri	R1	GEOSCI	34	34.00	2,921	2,921	0.30	GEOS03	0.631	401.21
Adelphi University	2666	Pri	D2	GEOSCI	0	4.17	0	4	0.34	GEOS03	0.631	401.21
Boston University	2130	Pri	R1	GEOSCI	6	6.00	171	171	0.35	GEOS03	0.631	401.21
Tulane University of Louisiana	2029	Pri	R2	GEOSCI	0	6.10	7	7	0.41	GEOS03	0.631	401.21
Case Western Reserve University	3024	Pri	R1	GEOSCI	7	7.00	437	437	0.48	GEOS03	0.631	401.21
University of Rochester	2894	Pri	R1	GEOSCI	0	7.14	31	31	0.54	GEOS03	0.631	401.21
University of Tulsa	3185	Pri	D2	GEOSCI	5	5.00	9	9	0.54	GEOS03	0.631	401.21
Northwestern University	1739	Pri	R1	GEOSCI	13	13.00	359	359	0.56	GEOS03	0.631	401.21
Nova University	1509	Pri	D1	GEOSCI	0	4.04	703	703	0.59	GEOS03	0.631	401.21
Howard University	1448	Pri	R1	GEOSCI	0	23.47	0	23	0.59	GEOS03	0.631	401.21
Boston College	2128	Pri	D1	GEOSCI	0	17.22	1,264	1,264	0.63	GEOS03	0.631	401.21
Drexel University	3256	Pri	D2	GEOSCI	0	9.10	0	9	0.65	GEOS03	0.631	401.21
Hofstra University	2732	Pri	D2	GEOSCI	0	4.36	1	1	0.68	GEOS03	0.631	401.21
Texas Christian University	3636	Pri	D2	GEOSCI	0	5.50	0	5	0.72	GEOS03	0.631	401.21
Drake University	1860	Pri	D2	GEOSCI	0	4.36	1	1	0.79	GEOS03	0.631	401.21
Tufts University	2219	Pri	D1	GEOSCI	0	2.62	0	3	0.81	GEOS03	0.631	401.21
Baylor University	6967	Pri	D2	GEOSCI	0	7.20	0	7	0.81	GEOS03	0.631	401.21
Illinois Institute of Technology	1691	Pri	D1	GEOSCI	0	0.95	327	327	0.86	GEOS03	0.631	401.21
Vanderbilt University	3535	Pri	R1	GEOSCI	0	9.69	82	82	0.86	GEOS03	0.631	401.21

Table 5-A.4: Segmentation Array: GeoSciences

School	FICE	TOC	Carnegie Class	Academic Discipline	Faculty	Faculty (adjusted)	R&D Expenditures	R&D Exp (adjusted)	Factor Score	Segment	Segment RU Fraction	Segment Faculty
Northeastern University	2199	Pri	D2	GEOSCI	0	5.85	9	9	0.86	GEOS03	0.631	401.21
New York University	2785	Pri	R1	GEOSCI	0	14.65	295	295	0.89	GEOS03	0.631	401.21
Emory University	1564	Pri	R2	GEOSCI	0	9.92	2	2	0.91	GEOS03	0.631	401.21
University of Notre Dame	1840	Pri	D1	GEOSCI	0	4.68	17	17	0.91	GEOS03	0.631	401.21
Andrews University	2238	Pri	D2	GEOSCI	0	2.35	0	2	0.93	GEOS03	0.631	401.21
Clark University	2139	Pri	D2	GEOSCI	0	1.82	35	35	0.96	GEOS03	0.631	401.21
University of San Francisco	1325	Pri	D2	GEOSCI	0	1.77	0	2	0.97	GEOS03	0.631	401.21
Loma Linda University	1218	Pri	D2	GEOSCI	0	7.79	0	8	0.98	GEOS03	0.631	401.21
Stevens Institute of Technology	2,639	Pri	D2	GEOSCI	0	0.95	87	87	0.99	GEOS03	0.631	401.21
University of Denver	1371	Pri	D1	GEOSCI	0	5.85	0	6	1.01	GEOS03	0.631	401.21
Brandeis University	2133	Pri	R2	GEOSCI	0	4.68	0	5	1.02	GEOS03	0.631	401.21
Columbia University, Teachers College	3979	Pri	D1	GEOSCI	0	0.95	0	1	1.04	GEOS03	0.631	401.21
American University	1434	Pri	D1	GEOSCI	0 •		0 •		•	GEOS03	0.631	401.21
Biola University	1122	Pri	D2	GEOSCI	0 •		0 •		•	GEOS03	0.631	401.21
Carnegie Mellon University	3242	Pri	R1	GEOSCI	0 •		1,754	1,754	•	GEOS03	0.631	401.21
Catholic University of America	1437	Pri	D1	GEOSCI	0 •		0 •		•	GEOS03	0.631	401.21
Claremont Univ Center & Graduate School	1169	Pri	D1	GEOSCI	0 •		0 •		•	GEOS03	0.631	401.21
Clark Atlanta University	1559	Pri	D2	GEOSCI	0 •		0 •		•	GEOS03	0.631	401.21
Clarkson University	2699	Pri	D2	GEOSCI	0 •		0 •		•	GEOS03	0.631	401.21
Duquesne University	3258	Pri	D2	GEOSCI	0 •		0 •		•	GEOS03	0.631	401.21
Fordham University	2722	Pri	D1	GEOSCI	0 •		0 •		•	GEOS03	0.631	401.21
Georgetown University	1445	Pri	R2	GEOSCI	0 •		0 •		•	GEOS03	0.631	401.21
Hahnemann University	3271	Pri	D2	GEOSCI	0 •		0 •		•	GEOS03	0.631	401.21
Loyola University of Chicago	1710	Pri	D1	GEOSCI	0 •		9	9	•	GEOS03	0.631	401.21
Marquette University	3863	Pri	D1	GEOSCI	0 •		0 •		•	GEOS03	0.631	401.21
New School For Social Research	2780	Pri	D2	GEOSCI	0 •		0 •		•	GEOS03	0.631	401.21
Pepperdine University	1264	Pri	D2	GEOSCI	0 •		0 •		•	GEOS03	0.631	401.21
Polytechnic University	2796	Pri	D2	GEOSCI	0 •		0 •		•	GEOS03	0.631	401.21
Rockefeller University	2807	Pri	R1	GEOSCI	0 •		0 •		•	GEOS03	0.631	401.21
Saint John's University New York	2823	Pri	D1	GEOSCI	0 •		14	14	•	GEOS03	0.631	401.21
Union Institute	10923	Pri	D1	GEOSCI	0 •		0 •		•	GEOS03	0.631	401.21
Yeshiva University	2903	Pri	R1	GEOSCI	0 •		0 •		•	GEOS03	0.631	401.21
University of Wisconsin-Madison	3895	Pub	R1	GEOSCI	19	19.00	13,130	13,130	-4.85	GEOS04	1.000	56.00
University of Washington	3798	Pub	R1	GEOSCI	17	17.00	16,413	16,413	-4.69	GEOS04	1.000	56.00
Oregon State University	3210	Pub	R1	GEOSCI	12	12.00	10,176	10,176	-4.18	GEOS04	1.000	56.00
SUNY at Albany	2835	Pub	R2	GEOSCI	8	8.00	2,328	2,328	-3.11	GEOS04	1.000	56.00
Florida State University	1489	Pub	R2	GEOSCI	10	10.00	3,594	3,594	-2.90	GEOS05	1.000	104.12
University of California-San Diego	1317	Pub	R1	GEOSCI	0	35.12	59,965	59,965	-2.45	GEOS05	1.000	104.12
University of Oklahoma, Norman Campus	3184	Pub	R2	GEOSCI	13	13.00	7,462	7,462	-2.26	GEOS05	1.000	104.12
University of Illinois at Urbana-Champaign	1775	Pub	R1	GEOSCI	20	20.00	7,405	7,405	-1.71	GEOS05	1.000	104.12
University of California-Berkeley	1312	Pub	R1	GEOSCI	16	16.00	2,512	2,512	-1.64	GEOS05	1.000	104.12
University of Delaware	1431	Pub	R2	GEOSCI	10	10.00	3,109	3,109	-1.62	GEOS05	1.000	104.12
University of Michigan at Ann Arbor	9092	Pub	R1	GEOSCI	20	20.00	12,147	12,147	-1.62	GEOS06	0.839	108.51
University of Arizona	1083	Pub	R1	GEOSCI	26	26.00	12,105	12,105	-1.57	GEOS06	0.839	108.51

Table 5-A.4: Segmentation Array: GeoSciences

School	FICE	TOC	Carnegie Class	Academic Discipline	Faculty	Faculty (adjusted)	R&D Expenditures	R&D Exp (adjusted)	Factor Score	Segment	Segment RU Fraction	Segment Faculty
Texas A & M University, Main Campus	10366	Pub	R1	GEOSCI	31	31.00	5567	5567	-1.52	GEOS06	0.839	108.51
Colorado School of Mines	1348	Pub	D2	GEOSCI	0	16.56	1,252	1,252	-1.51	GEOS06	0.839	108.51
University of New Mexico, All Campuses	10313	Pub	R1	GEOSCI	14	14.00	886	886	-1.44	GEOS06	0.839	108.51
SUNY College of Environmental Science and F	2851	Pub	D2	GEOSCI	0	0.95	1,362	1,362	-1.29	GEOS06	0.839	108.51
University of Colorado at Boulder	1370	Pub	R1	GEOSCI	19	19.00	5,641	5,641	-1.09	GEOS07	0.902	102.32
University of Missouri, Columbia	2516	Pub	R1	GEOSCI	8	8.00	643	643	-1.04	GEOS07	0.902	102.32
University of California-Los Angeles	1315	Pub	R1	GEOSCI	39	39.00	6,721	6,721	-1.01	GEOS07	0.902	102.32
Washington State University	3800	Pub	R2	GEOSCI	10	10.00	285	285	-0.98	GEOS07	0.902	102.32
SUNY at Binghamton	2836	Pub	D1	GEOSCI	10	10.00	349	349	-0.90	GEOS07	0.902	102.32
University of Rhode Island	3414	Pub	R2	GEOSCI	0	16.32	11,385	11,385	-0.88	GEOS07	0.902	102.32
University of Texas at Dallas	9741	Pub	D2	GEOSCI	12	12.00	711	711	-0.85	GEOS08	0.873	173.79
University of Utah	3675	Pub	R1	GEOSCI	24	24.00	2,859	2,859	-0.85	GEOS08	0.873	173.79
University of California-Davis	1313	Pub	R1	GEOSCI	12	12.00	466	466	-0.77	GEOS08	0.873	173.79
University of Wyoming	3932	Pub	R2	GEOSCI	17	17.00	3,170	3,170	-0.64	GEOS08	0.873	173.79
University of South Carolina at Columbia	3448	Pub	R2	GEOSCI	20	20.00	1,691	1,691	-0.59	GEOS08	0.873	173.79
Colorado State University	1350	Pub	R1	GEOSCI	0	22.79	2,249	2,249	-0.58	GEOS08	0.873	173.79
University of California-Santa Barbara	1320	Pub	R2	GEOSCI	18	18.00	3,112	3,112	-0.53	GEOS08	0.873	173.79
University of California-Santa Cruz	1321	Pub	D1	GEOSCI	10	10.00	1,007	1,007	-0.47	GEOS08	0.873	173.79
Pennsylvania State U, Main Campus	6965	Pub	R1	GEOSCI	38	38.00	7,181	7,181	-0.44	GEOS08	0.873	173.79
SUNY at Buffalo, Main Campus	2837	Pub	R2	GEOSCI	0	9.10	750	750	-0.33	GEOS09	0.824	260.20
University of Pittsburgh Main Campus	3379	Pub	R1	GEOSCI	12	12.00	1,144	1,144	-0.33	GEOS09	0.824	260.20
University of Texas at Austin	3658	Pub	R1	GEOSCI	37	37.00	13,452	13,452	-0.32	GEOS09	0.824	260.20
University of North Carolina at Chapel Hill	2974	Pub	R1	GEOSCI	15	15.00	3,060	3,060	-0.30	GEOS09	0.824	260.20
University of Georgia	1598	Pub	R1	GEOSCI	0	17.40	2,149	2,149	-0.28	GEOS09	0.824	260.20
University of Tennessee at Knoxville	3530	Pub	R1	GEOSCI	9	9.00	0	10	-0.27	GEOS09	0.824	260.20
Idaho State University	1620	Pub	D2	GEOSCI	0	3.36	49	49	-0.26	GEOS09	0.824	260.20
University of Houston-University Park	3652	Pub	D1	GEOSCI	14	14.00	768	768	-0.25	GEOS09	0.824	260.20
Texas Tech University	3644	Pub	D1	GEOSCI	0	11.35	647	647	-0.23	GEOS09	0.824	260.20
University of Hawaii at Manoa	1610	Pub	R1	GEOSCI	33	33.00	9,720	9,720	-0.21	GEOS09	0.824	260.20
University of Kentucky, Main Campus	1989	Pub	R1	GEOSCI	9	9.00	863	863	-0.21	GEOS09	0.824	260.20
University of California-Riverside	1316	Pub	D1	GEOSCI	8	8.00	652	652	-0.17	GEOS09	0.824	260.20
North Carolina State University at Raleigh	2972	Pub	R1	GEOSCI	0	15.62	3,153	3,153	-0.17	GEOS09	0.824	260.20
West Virginia University	3827	Pub	R2	GEOSCI	16	16.00	670	670	-0.14	GEOS09	0.824	260.20
University of Nevada-Reno	2568	Pub	D2	GEOSCI	0	9.10	444	444	-0.12	GEOS09	0.824	260.20
Purdue University, Main Campus	1825	Pub	R1	GEOSCI	22	22.00	841	841	-0.12	GEOS09	0.824	260.20
University of Florida	1535	Pub	R1	GEOSCI	0	5.28	541	541	-0.08	GEOS09	0.824	260.20
Michigan State University	2290	Pub	R1	GEOSCI	14	14.00	2,542	2,542	-0.04	GEOS09	0.824	260.20
Virginia Polytechnic Institute and State Univ	3754	Pub	R1	GEOSCI	22	22.00	2,444	2,444	-0.04	GEOS10	0.496	853.35
Rutgers, the State University at New Brunswick	6964	Pub	R1	GEOSCI	0	20.22	2,859	2,859	-0.04	GEOS10	0.496	853.35
University of Maryland at College Park	2103	Pub	R1	GEOSCI	0	11.62	652	652	0.01	GEOS10	0.496	853.35
Arizona State University	1081	Pub	R2	GEOSCI	19	19.00	864	864	0.02	GEOS10	0.496	853.35
University of Montana	2536	Pub	D1	GEOSCI	13	13.00	280	280	0.03	GEOS10	0.496	853.35
University of North Dakota, All Campuses	3005	Pub	D2	GEOSCI	8	8.00	756	756	0.04	GEOS10	0.496	853.35
University of Cincinnati, All Campuses	3125	Pub	R1	GEOSCI	11	11.00	223	223	0.04	GEOS10	0.496	853.35

Table 5-A.4: Segmentation Array: GeoSciences

School	FICE	TOC	Carnegie Class	Academic Discipline	Faculty	Faculty (adjusted)	R&D Expenditures	R&D Exp (adjusted)	Factor Score	Segment	Segment RU Fraction	Segment Faculty
University of Maine at Orono	2053	Pub	D2	GEOSCI	0	17.04	2,826	2,826	0.12	GEOS10	0.496	853.35
SUNY at Stony Brook, All Campuses	2838	Pub	R1	GEOSCI	25	25.00	3,900	3,900	0.17	GEOS10	0.496	853.35
Illinois State University	1692	Pub	D2	GEOSCI	0	3.36	0	3	0.17	GEOS10	0.496	853.35
University of Arkansas, Main Campus	1108	Pub	D1	GEOSCI	0	6.68	406	406	0.20	GEOS10	0.496	853.35
University of Texas at Arlington	3656	Pub	D2	GEOSCI	0	8.10	16	16	0.21	GEOS10	0.496	853.35
Kent State University, All Campuses	3051	Pub	D1	GEOSCI	0	8.28	31	31	0.23	GEOS10	0.496	853.35
Georgia Institute of Technology, Main Campus	1569	Pub	R1	GEOSCI	0	11.04	2,404	2,404	0.25	GEOS10	0.496	853.35
University of Kansas, Main Campus	1948	Pub	R2	GEOSCI	18	18.00	1,506	1,506	0.28	GEOS10	0.496	853.35
Old Dominion University	3728	Pub	D2	GEOSCI	0	15.19	671	671	0.30	GEOS10	0.496	853.35
University of Iowa	1892	Pub	R1	GEOSCI	14	14.00	127	127	0.31	GEOS10	0.496	853.35
Bowling Green State University, All Campuses	3018	Pub	D1	GEOSCI	0	6.68	215	215	0.32	GEOS10	0.496	853.35
University of Minnesota at Twin Cities	3969	Pub	R1	GEOSCI	21	21.00	2,190	2,190	0.33	GEOS10	0.496	853.35
University of Wisconsin-Milwaukee	3896	Pub	D1	GEOSCI	0	18.48	1,549	1,549	0.34	GEOS10	0.496	853.35
University of Nebraska at Lincoln	2565	Pub	R2	GEOSCI	0	12.97	4,865	4,865	0.34	GEOS10	0.496	853.35
Portland State University	3216	Pub	D2	GEOSCI	0	6.68	26	26	0.35	GEOS10	0.496	853.35
Ohio University, All Campuses	3100	Pub	D1	GEOSCI	0	6.89	42	42	0.35	GEOS10	0.496	853.35
Miami University, All Campuses	7104	Pub	D1	GEOSCI	0	13.82	23	23	0.35	GEOS10	0.496	853.35
University of Connecticut, Main Campus	29013	Pub	R1	GEOSCI	0	14.31	1,007	1,007	0.35	GEOS10	0.496	853.35
Indiana University at Bloomington	1809	Pub	R1	GEOSCI	23	23.00	562	562	0.36	GEOS10	0.496	853.35
Western Michigan University	2330	Pub	D1	GEOSCI	0	5.85	23	23	0.37	GEOS10	0.496	853.35
University of North Texas	3594	Pub	D1	GEOSCI	0	4.04	977	977	0.37	GEOS10	0.496	853.35
Southern Illinois University-Carbondale	1756	Pub	R2	GEOSCI	0	11.04	1,121	1,121	0.37	GEOS10	0.496	853.35
University of Idaho	1626	Pub	D2	GEOSCI	13	13.00	801	801	0.39	GEOS10	0.496	853.35
College of William and Mary	3705	Pub	D1	GEOSCI	0	26.44	4	4	0.39	GEOS10	0.496	853.35
Northern Arizona University	1082	Pub	D2	GEOSCI	0	9.49	108	108	0.42	GEOS10	0.496	853.35
Oklahoma State University, All Campuses	3170	Pub	R2	GEOSCI	0	8.28	272	272	0.42	GEOS10	0.496	853.35
University of New Hampshire, Main Campus	2589	Pub	D2	GEOSCI	0	12.95	1,929	1,929	0.43	GEOS10	0.496	853.35
Utah State University	3677	Pub	R2	GEOSCI	0	14.56	4,886	4,886	0.43	GEOS10	0.496	853.35
University of Vermont	3696	Pub	D2	GEOSCI	0	6.54	37	37	0.43	GEOS10	0.496	853.35
Memphis State University	3509	Pub	D1	GEOSCI	0	5.50	1	1	0.43	GEOS10	0.496	853.35
Ohio State University, Main Campus	6883	Pub	R1	GEOSCI	30	30.00	1,464	1,464	0.46	GEOS10	0.496	853.35
University of Akron, All Campuses	3123	Pub	D1	GEOSCI	0	8.93	47	47	0.48	GEOS10	0.496	853.35
University of Missouri, Rolla	2517	Pub	D2	GEOSCI	12	12.00	203	203	0.49	GEOS10	0.496	853.35
University of New Orleans	2015	Pub	D2	GEOSCI	0	8.30	4	4	0.49	GEOS10	0.496	853.35
Northern Illinois University	1737	Pub	D1	GEOSCI	0	15.27	558	558	0.52	GEOS10	0.496	853.35
University of South Florida	1537	Pub	D1	GEOSCI	0	14.63	531	531	0.53	GEOS10	0.496	853.35
University of Oregon	3223	Pub	R2	GEOSCI	13	13.00	785	785	0.55	GEOS10	0.496	853.35
University of Northern Colorado	1349	Pub	D1	GEOSCI	0	5.26	0	5	0.56	GEOS10	0.496	853.35
Kansas State University of Agriculture and App	1928	Pub	R2	GEOSCI	0	6.89	671	671	0.57	GEOS10	0.496	853.35
Montana State University	2532	Pub	D2	GEOSCI	0	10.31	781	781	0.59	GEOS10	0.496	853.35
University of Massachusetts at Amherst	2221	Pub	R2	GEOSCI	16	16.00	2,524	2,524	0.60	GEOS10	0.496	853.35
University of Alabama	1051	Pub	D1	GEOSCI	0	8.66	12	12	0.61	GEOS10	0.496	853.35
University of Mississippi, Main Campus	2440	Pub	D1	GEOSCI	0	4.68	108	108	0.61	GEOS10	0.496	853.35
Ball State University	1786	Pub	D1	GEOSCI	0	5.85	0	6	0.62	GEOS10	0.496	853.35

Table 5-A.4: Segmentation Array: GeoSciences

School	FICE	TOC	Carnegie Class	Academic Discipline	Faculty	Faculty (adjusted)	R&D Expenditures	R&D Exp (adjusted)	Factor Score	Segment	Segment RU Fraction	Segment Faculty
East Texas State University, All Campuses	3565	Pub	D2	GEOSCI	0	6.39	0	6	0.63	GEOS10	0.496	853.35
Iowa State University	1869	Pub	R2	GEOSCI	18	18.00	1,033	1,033	0.64	GEOS10	0.496	853.35
Wayne State University	2329	Pub	R2	GEOSCI	0	6.68	8	8	0.64	GEOS10	0.496	853.35
University of Toledo	3131	Pub	D1	GEOSCI	0	11.24	0	11	0.69	GEOS10	0.496	853.35
University of Virginia, Main Campus	6968	Pub	R1	GEOSCI	26	26.00	1,680	1,680	0.71	GEOS10	0.496	853.35
Florida Atlantic University	1481	Pub	D2	GEOSCI	0	5.44	88	88	0.76	GEOS10	0.496	853.35
New Mexico State University, All Campuses	2657	Pub	R1	GEOSCI	0	8.30	1,215	1,215	0.76	GEOS10	0.496	853.35
Auburn University, Main Campus	1009	Pub	R2	GEOSCI	0	10.10	5	5	0.80	GEOS10	0.496	853.35
University of South Dakota	3474	Pub	D2	GEOSCI	0	7.23	0	7	0.81	GEOS10	0.496	853.35
University of Illinois at Chicago	1776	Pub	R1	GEOSCI	0	11.97	545	545	0.82	GEOS10	0.496	853.35
Mississippi State University	2423	Pub	R2	GEOSCI	0	6.67	85	85	0.83	GEOS10	0.496	853.35
University of Southern Mississippi	2441	Pub	D1	GEOSCI	0	4.68	80	80	0.83	GEOS10	0.496	853.35
Tennessee Technological University	3523	Pub	D2	GEOSCI	0	6.67	50	50	0.84	GEOS10	0.496	853.35
University of Missouri, Kansas City	2518	Pub	D2	GEOSCI	0	6.89	0	7	0.84	GEOS10	0.496	853.35
Temple University	3371	Pub	R2	GEOSCI	0	12.30	17	17	0.85	GEOS10	0.496	853.35
University of Alabama at Birmingham	1052	Pub	D2	GEOSCI	0	4.17	0	4	0.86	GEOS10	0.496	853.35
Indiana State University, Terre Haute	9563	Pub	D2	GEOSCI	0	10.57	14	14	0.87	GEOS10	0.496	853.35
Cleveland State University	3032	Pub	D2	GEOSCI	0	6.54	14	14	0.87	GEOS10	0.496	853.35
Georgia State University	1574	Pub	D1	GEOSCI	0	8.19	8	8	0.90	GEOS10	0.496	853.35
University of Louisville	1999	Pub	D1	GEOSCI	0	6.89	38	38	0.93	GEOS10	0.496	853.35
North Dakota State University, All Campuses	9265	Pub	D2	GEOSCI	0	13.49	40	40	0.94	GEOS10	0.496	853.35
Clemson University	3425	Pub	D1	GEOSCI	0	5.85	0	6	0.95	GEOS10	0.496	853.35
University of Maryland Baltimore County	2105	Pub	D2	GEOSCI	0	7.71	0	8	0.99	GEOS10	0.496	853.35
University of North Carolina at Greensboro	2976	Pub	D2	GEOSCI	0	4.86	0	5	1.00	GEOS10	0.496	853.35
Middle Tennesse State University	3510	Pub	D2	GEOSCI	0	1.82	0	2	1.03	GEOS10	0.496	853.35
University of Missouri, Saint Louis	2519	Pub	D2	GEOSCI	0	1.82	0	2	1.03	GEOS10	0.496	853.35
CUNY Graduate School and University Center	4063	Pub	D1	GEOSCI	0 •		0 •		•	GEOS10	0.496	853.35
Louisiana State University and Agric & Mech Cc	2010	Pub	R1	GEOSCI	0 •		0 •		•	GEOS10	0.496	853.35
Louisiana Tech University	2008	Pub	D2	GEOSCI	0 •		0 •		•	GEOS10	0.496	853.35
Texas Woman's University	3646	Pub	D1	GEOSCI	0 •		0 •		•	GEOS10	0.496	853.35
University of California-Irvine	1314	Pub	R1	GEOSCI	0 •		0 •		•	GEOS10	0.496	853.35
University of California-San Francisco	1319	Pub	R1	GEOSCI	0 •		0 •		•	GEOS10	0.496	853.35
Virginia Commonwealth University	3735	Pub	R2	GEOSCI	0 •		0 •		•	GEOS10	0.496	853.35

Table 5-A.5: Segmentation Array: Mathematics and Statistics

School	FICE	TOC	Carnegie Class	Academic Discipline	Faculty	Faculty (adjusted)	R&D Expenditures	R&D Exp (adjusted)	Factor Score	Segment	Segment RU Fraction	Segment Faculty
George Washington University	1444	Pri	R2	MathStat	3	3.00	1,124	1,124	-12.21	MATH01	0.910	188.00
American University	1434	Pri	D1	MathStat	6	6.00	5	5	-3.58	MATH01	0.910	188.00
New York University	2785	Pri	R1	MathStat	37	37.00	3,777	3,777	-1.58	MATH01	0.910	188.00
Johns Hopkins University	2077	Pri	R1	MathStat	20	20.00	172	172	-1.21	MATH01	0.910	188.00
Harvard University	2155	Pri	R1	MathStat	33	33.00	931	931	-1.10	MATH01	0.910	188.00
Stanford University	1305	Pri	R1	MathStat	46	46.00	3,081	3,081	-1.08	MATH01	0.910	188.00
Southern Methodist University	3613	Pri	D2	MathStat	11	11.00	114	114	-1.07	MATH01	0.910	188.00
Princeton University	2627	Pri	R1	MathStat	32	32.00	1,554	1,554	-0.85	MATH01	0.910	188.00
Massachusetts Institute of Technology	2178	Pri	R1	MathStat	53	53.00	1,163	1,163	-0.80	MATH02	0.849	179.00
Rice University	3604	Pri	D1	MathStat	14	14.00	223	223	-0.77	MATH02	0.849	179.00
Brown University	3401	Pri	R2	MathStat	43	43.00	1,300	1,300	-0.77	MATH02	0.849	179.00
Saint Louis University, Main Campus	2506	Pri	D1	MathStat	7	7.00	0	12	-0.75	MATH02	0.849	179.00
Washington University	2520	Pri	R1	MathStat	21	21.00	714	714	-0.69	MATH02	0.849	179.00
Brandeis University	2133	Pri	R2	MathStat	12	12.00	231	231	-0.64	MATH02	0.849	179.00
Boston University	2130	Pri	R1	MathStat	23	23.00	97	97	-0.54	MATH02	0.849	179.00
Illinois Institute of Technology	1691	Pri	D1	MathStat	6	6.00	36	36	-0.48	MATH02	0.849	179.00
Yale University	1426	Pri	R1	MathStat	34	34.00	569	569	-0.42	MATH03	0.821	251.00
Adelphi University	2666	Pri	D2	MathStat	14	14.00	35	35	-0.39	MATH03	0.821	251.00
California Institute of Technology	1131	Pri	R1	MathStat	20	20.00	236	236	-0.36	MATH03	0.821	251.00
Vanderbilt University	3535	Pri	R1	MathStat	19	19.00	52	52	-0.34	MATH03	0.821	251.00
University of Chicago	1774	Pri	R1	MathStat	42	42.00	1,103	1,103	-0.27	MATH03	0.821	251.00
Stevens Institute of Technology	2639	Pri	D2	MathStat	12	12.00	3	3	-0.26	MATH03	0.821	251.00
Dartmouth College	2573	Pri	D2	MathStat	19	19.00	56	56	-0.22	MATH03	0.821	251.00
Cornell University, All Campuses	2711	Pri	R1	MathStat	62	62.00	533	533	-0.22	MATH03	0.821	251.00
Rensselaer Polytechnic Institute	2803	Pri	R2	MathStat	29	29.00	563	563	-0.21	MATH03	0.821	251.00
Carnegie Mellon University	3242	Pri	R1	MathStat	36	36.00	660	660	-0.20	MATH04	0.436	950.07
University of Notre Dame	1840	Pri	D1	MathStat	19	19.00	118	118	-0.17	MATH04	0.436	950.07
Lehigh University	3289	Pri	D1	MathStat	0	25.56	503	503	-0.15	MATH04	0.436	950.07
Duke University	2920	Pri	R1	MathStat	21	21.00	138	138	-0.15	MATH04	0.436	950.07
Yeshiva University	2903	Pri	R1	MathStat	0	7.44	66	66	-0.14	MATH04	0.436	950.07
Clarkson University	2699	Pri	D2	MathStat	17	17.00	210	210	-0.05	MATH04	0.436	950.07
Columbia University, Main Campus	2707	Pri	R1	MathStat	36	36.00	532	532	-0.04	MATH04	0.436	950.07
University of Rochester	2894	Pri	R1	MathStat	37	37.00	272	272	-0.02	MATH04	0.436	950.07
University of Denver	1371	Pri	D1	MathStat	16	16.00	162	162	0.01	MATH04	0.436	950.07
Polytechnic University	2796	Pri	D2	MathStat	13	13.00	62	62	0.03	MATH04	0.436	950.07
Georgetown University	1445	Pri	R2	MathStat	0	9.15	0	9	0.11	MATH04	0.436	950.07
Texas Christian University	3636	Pri	D2	MathStat	0	9.15	48	48	0.11	MATH04	0.436	950.07
University of Pennsylvania	3378	Pri	R1	MathStat	43	43.00	936	936	0.15	MATH04	0.436	950.07
Boston College	2128	Pri	D1	MathStat	0	39.13	1,863	1,863	0.19	MATH04	0.436	950.07
Emory University	1564	Pri	R2	MathStat	17	17.00	19	19	0.19	MATH04	0.436	950.07
University of Miami	1536	Pri	R1	MathStat	0	20.42	59	59	0.20	MATH04	0.436	950.07
Northeastern University	2199	Pri	D2	MathStat	38	38.00	140	140	0.21	MATH04	0.436	950.07
Syracuse University, Main Campus	2882	Pri	R2	MathStat	28	28.00	319	319	0.24	MATH04	0.436	950.07
Northwestern University	1739	Pri	R1	MathStat	39	39.00	361	361	0.26	MATH04	0.436	950.07

Table 5-A.5: Segmentation Array: Mathematics and Statistics

School	FICE	TOC	Carnegie Class	Academic Discipline	Faculty	Faculty (adjusted)	R&D Expenditures	R&D Exp (adjusted)	Factor Score	Segment	Segment RU Fraction	Segment Faculty
Baylor University	6967	Pri	D2	MathStat	0	14.78	0	15	0.29	MATH04	0.436	950.07
University of Southern California	1328	Pri	R1	MathStat	29	29.00	141	141	0.29	MATH04	0.436	950.07
Clark Atlanta University	1559	Pri	D2	MathStat	0	11.61	86	86	0.30	MATH04	0.436	950.07
Rockefeller University	2807	Pri	R1	MathStat	0	10.06	651	651	0.31	MATH04	0.436	950.07
Clark University	2139	Pri	D2	MathStat	0	6.47	28	28	0.32	MATH04	0.436	950.07
Case Western Reserve University	3024	Pri	R1	MathStat	32	32.00	55	55	0.32	MATH04	0.436	950.07
Drexel University	3256	Pri	D2	MathStat	0	26.88	86	86	0.34	MATH04	0.436	950.07
Loyola University of Chicago	1710	Pri	D1	MathStat	0	24.20	0	24	0.37	MATH04	0.436	950.07
Catholic University of America	1437	Pri	D1	MathStat	0	11.68	8	8	0.37	MATH04	0.436	950.07
Tufts University	2219	Pri	D1	MathStat	0	18.58	44	44	0.38	MATH04	0.436	950.07
Marquette University	3863	Pri	D1	MathStat	0	20.22	12	12	0.38	MATH04	0.436	950.07
Saint John's University New York	2823	Pri	D1	MathStat	0	26.88	8	8	0.38	MATH04	0.436	950.07
Tulane University of Louisiana	2029	Pri	R2	MathStat	27	27.00	182	182	0.39	MATH04	0.436	950.07
Andrews University	2238	Pri	D2	MathStat	0	4.78	0	5	0.42	MATH04	0.436	950.07
Nova University	1509	Pri	D1	MathStat	0	2.69	0	3	0.42	MATH04	0.436	950.07
Fordham University	2722	Pri	D1	MathStat	0	22.83	25	25	0.43	MATH04	0.436	950.07
Florida Institute of Technology	1469	Pri	D2	MathStat	0	17.87	0	18	0.43	MATH04	0.436	950.07
University of Tulsa	3185	Pri	D2	MathStat	0	16.30	1	1	0.44	MATH04	0.436	950.07
Claremont Univ Center & Graduate School	1169	Pri	D1	MathStat	15	15.00	95	95	0.46	MATH04	0.436	950.07
Loma Linda University	1218	Pri	D2	MathStat	0	19.93	685	685	0.48	MATH04	0.436	950.07
Brigham Young University, Main Campus	3670	Pri	D1	MathStat	0	35.45	0	35	0.50	MATH04	0.436	950.07
Hofstra University	2732	Pri	D2	MathStat	0	18.20	1	1	0.53	MATH04	0.436	950.07
Duquesne University	3258	Pri	D2	MathStat	0	10.00	0	10	0.60	MATH04	0.436	950.07
Howard University	1448	Pri	R1	MathStat	0	22.12	52	52	0.61	MATH04	0.436	950.07
University of San Francisco	1325	Pri	D2	MathStat	0	8.36	0	8	0.61	MATH04	0.436	950.07
Drake University	1860	Pri	D2	MathStat	0	10.84	20	20	0.63	MATH04	0.436	950.07
Biola University	1122	Pri	D2	MathStat	0	4.34	0	4	0.65	MATH04	0.436	950.07
Pepperdine University	1264	Pri	D2	MathStat	0	4.61	0	5	0.68	MATH04	0.436	950.07
Columbia University, Teachers College	3979	Pri	D1	MathStat	0	5.55	0	6	0.72	MATH04	0.436	950.07
Hahnemann University	3271	Pri	D2	MathStat	0	0.99	0	1	0.75	MATH04	0.436	950.07
New School For Social Research	2780	Pri	D2	MathStat	0 •		0 •		•	MATH04	0.436	950.07
Union Institute	10923	Pri	D1	MathStat	0 •		0 •		•	MATH04	0.436	950.07
Texas A & M University, Main Campus	10366	Pub	R1	MathStat	18	18.00	546	546	-1.29	MATH05	1.000	246.00
SUNY at Stony Brook, All Campuses	2838	Pub	R1	MathStat	36	36.00	644	644	-1.15	MATH05	1.000	246.00
University of California-Berkeley	1312	Pub	R1	MathStat	96	96.00	1,662	1,662	-1.10	MATH05	1.000	246.00
University of Wyoming	3932	Pub	R2	MathStat	7	7.00	23	23	-1.08	MATH05	1.000	246.00
Virginia Commonwealth University	3735	Pub	R2	MathStat	5	5.00	31	31	-0.87	MATH05	1.000	246.00
University of Wisconsin-Madison	3895	Pub	R1	MathStat	84	84.00	3,768	3,768	-0.68	MATH05	1.000	246.00
SUNY at Binghamton	2836	Pub	D1	MathStat	17	17.00	51	51	-0.65	MATH06	0.564	370.45
Florida State University	1489	Pub	R2	MathStat	42	42.00	849	849	-0.62	MATH06	0.564	370.45
University of Virginia, Main Campus	6968	Pub	R1	MathStat	26	26.00	181	181	-0.60	MATH06	0.564	370.45
University of Texas at Dallas	9741	Pub	D2	MathStat	0	23.22	106	106	-0.48	MATH06	0.564	370.45
University of Georgia	1598	Pub	R1	MathStat	30	30.00	575	575	-0.46	MATH06	0.564	370.45
University of Houston-University Park	3652	Pub	D1	MathStat	25	25.00	124	124	-0.42	MATH06	0.564	370.45

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Table 5-A.5: Segmentation Array: Mathematics and Statistics

School	FICE	TOC	Carnegie Class	Academic Discipline	Faculty	Faculty (adjusted)	R&D Expenditures	R&D Exp (adjusted)	Factor Score	Segment	Segment RU Fraction	Segment Faculty
Kansas State University of Agriculture and App	1928	Pub	R2	MathStat	13	13.00	48	48	-0.36	MATH06	0.564	370.45
University of Northern Colorado	1349	Pub	D1	MathStat	0	11.61	0	12	-0.33	MATH06	0.564	370.45
University of California-Santa Cruz	1321	Pub	D1	MathStat	0	14.10	450	450	-0.31	MATH06	0.564	370.45
Indiana University at Bloomington	1809	Pub	R1	MathStat	35	35.00	455	455	-0.28	MATH06	0.564	370.45
Memphis State University	3509	Pub	D1	MathStat	0	23.52	0	24	-0.28	MATH06	0.564	370.45
University of California-Santa Barbara	1320	Pub	R2	MathStat	35	35.00	350	350	-0.27	MATH06	0.564	370.45
Kent State University, All Campuses	3051	Pub	D1	MathStat	24	24.00	59	59	-0.26	MATH06	0.564	370.45
University of Tennessee at Knoxville	3530	Pub	R1	MathStat	28	28.00	0	46	-0.25	MATH06	0.564	370.45
University of Texas at Arlington	3656	Pub	D2	MathStat	23	23.00	50	50	-0.25	MATH06	0.564	370.45
University of Kentucky, Main Campus	1989	Pub	R1	MathStat	46	46.00	223	223	-0.24	MATH07	0.826	536.09
Clemson University	3425	Pub	D1	MathStat	28	28.00	182	182	-0.22	MATH07	0.826	536.09
SUNY at Albany	2835	Pub	R2	MathStat	28	28.00	112	112	-0.22	MATH07	0.826	536.09
University of Colorado at Boulder	1370	Pub	R1	MathStat	44	44.00	182	182	-0.20	MATH07	0.826	536.09
University of California-Riverside	1316	Pub	D1	MathStat	25	25.00	297	297	-0.19	MATH07	0.826	536.09
Pennsylvania State U, Main Campus	6965	Pub	R1	MathStat	58	58.00	390	390	-0.15	MATH07	0.826	536.09
Ohio State University, Main Campus	6883	Pub	R1	MathStat	65	65.00	566	566	-0.14	MATH07	0.826	536.09
University of Alabama	1051	Pub	D1	MathStat	19	19.00	5	5	-0.12	MATH07	0.826	536.09
University of Texas at Austin	3658	Pub	R1	MathStat	57	57.00	551	551	-0.10	MATH07	0.826	536.09
Purdue University, Main Campus	1825	Pub	R1	MathStat	80	80.00	336	336	-0.10	MATH07	0.826	536.09
Ball State University	1786	Pub	D1	MathStat	0	21.09	0	21	-0.09	MATH07	0.826	536.09
Michigan State University	2290	Pub	R1	MathStat	65	65.00	429	429	-0.07	MATH07	0.826	536.09
Rutgers, the State University at New Brunswick	6964	Pub	R1	MathStat	79	79.00	1,129	1,129	-0.06	MATH08	1.000	537.00
University of South Carolina at Columbia	3448	Pub	R2	MathStat	28	28.00	219	219	-0.06	MATH08	1.000	537.00
University of Illinois at Urbana-Champaign	1775	Pub	R1	MathStat	97	97.00	1,026	1,026	-0.05	MATH08	1.000	537.00
Iowa State University	1869	Pub	R2	MathStat	61	61.00	1,265	1,265	-0.04	MATH08	1.000	537.00
University of Oregon	3223	Pub	R2	MathStat	30	30.00	106	106	-0.03	MATH08	1.000	537.00
University of Michigan at Ann Arbor	9092	Pub	R1	MathStat	91	91.00	639	639	-0.03	MATH08	1.000	537.00
University of Iowa	1892	Pub	R1	MathStat	46	46.00	347	347	0.02	MATH08	1.000	537.00
University of Illinois at Chicago	1776	Pub	R1	MathStat	62	62.00	769	769	0.03	MATH08	1.000	537.00
SUNY at Buffalo, Main Campus	2837	Pub	R2	MathStat	43	43.00	210	210	0.03	MATH08	1.000	537.00
University of Minnesota at Twin Cities	3969	Pub	R1	MathStat	81	81.00	1,242	1,242	0.04	MATH09	0.782	948.69
Northern Illinois University	1737	Pub	D1	MathStat	0	38.54	611	611	0.05	MATH09	0.782	948.69
University of Connecticut, Main Campus	29013	Pub	R1	MathStat	31	31.00	232	232	0.05	MATH09	0.782	948.69
University of Nebraska at Lincoln	2565	Pub	R2	MathStat	34	34.00	52	52	0.05	MATH09	0.782	948.69
University of California-Los Angeles	1315	Pub	R1	MathStat	104	104.00	574	574	0.06	MATH09	0.782	948.69
University of Pittsburgh Main Campus	3379	Pub	R1	MathStat	51	51.00	1,184	1,184	0.10	MATH09	0.782	948.69
University of Wisconsin-Milwaukee	3896	Pub	D1	MathStat	21	21.00	68	68	0.11	MATH09	0.782	948.69
Western Michigan University	2330	Pub	D1	MathStat	32	32.00	12	12	0.14	MATH09	0.782	948.69
University of California-Irvine	1314	Pub	R1	MathStat	0	21.75	66	66	0.14	MATH09	0.782	948.69
Miami University, All Campuses	7104	Pub	D1	MathStat	0	35.71	5	5	0.15	MATH09	0.782	948.69
University of Florida	1535	Pub	R1	MathStat	52	52.00	182	182	0.16	MATH09	0.782	948.69
Oregon State University	3210	Pub	R1	MathStat	48	48.00	557	557	0.16	MATH09	0.782	948.69
Idaho State University	1620	Pub	D2	MathStat	0	12.96	26	26	0.16	MATH09	0.782	948.69
Ohio University, All Campuses	3100	Pub	D1	MathStat	25	25.00	51	51	0.16	MATH09	0.782	948.69

Table 5-A.5: Segmentation Array: Mathematics and Statistics

School	FICE	TOC	Carnegie Class	Academic Discipline	Faculty	Faculty (adjusted)	R&D Expenditures	R&D Exp (adjusted)	Factor Score	Segment	Segment RU Fraction	Segment Faculty
Virginia Polytechnic Institute and State Univ	3754	Pub	R1	MathStat	55	55.00	142	142	0.17	MATH09	0.782	948.69
University of North Carolina at Chapel Hill	2974	Pub	R1	MathStat	67	67.00	354	354	0.18	MATH09	0.782	948.69
Arizona State University	1081	Pub	R2	MathStat	0	32.06	31	31	0.19	MATH09	0.782	948.69
University of California-Davis	1313	Pub	R1	MathStat	32	32.00	56	56	0.19	MATH09	0.782	948.69
University of Montana	2536	Pub	D1	MathStat	19	19.00	31	31	0.21	MATH09	0.782	948.69
University of California-San Diego	1317	Pub	R1	MathStat	42	42.00	389	389	0.21	MATH09	0.782	948.69
University of New Hampshire, Main Campus	2589	Pub	D2	MathStat	0	22.67	45	45	0.21	MATH09	0.782	948.69
University of Washington	3798	Pub	R1	MathStat	91	91.00	493	493	0.22	MATH09	0.782	948.69
Oklahoma State University, All Campuses	3170	Pub	R2	MathStat	35	35.00	57	57	0.22	MATH10	0.559	1998.36
University of Missouri, Columbia	2516	Pub	R1	MathStat	34	34.00	75	75	0.23	MATH10	0.559	1998.36
University of Oklahoma, Norman Campus	3184	Pub	R2	MathStat	26	26.00	65	65	0.23	MATH10	0.559	1998.36
University of New Mexico, All Campuses	10313	Pub	R1	MathStat	37	37.00	112	112	0.26	MATH10	0.559	1998.36
University of Delaware	1431	Pub	R2	MathStat	38	38.00	342	342	0.27	MATH10	0.559	1998.36
Texas Woman's University	3646	Pub	D1	MathStat	0	4.78	1	1	0.27	MATH10	0.559	1998.36
Middle Tennesse State University	3510	Pub	D2	MathStat	0	15.46	0	15	0.27	MATH10	0.559	1998.36
Bowling Green State University, All Campuses	3018	Pub	D1	MathStat	25	25.00	61	61	0.27	MATH10	0.559	1998.36
Texas Tech University	3644	Pub	D1	MathStat	32	32.00	157	157	0.28	MATH10	0.559	1998.36
CUNY Graduate School and University Center	4063	Pub	D1	MathStat	26	26.00	114	114	0.28	MATH10	0.559	1998.36
University of Kansas, Main Campus	1948	Pub	R2	MathStat	34	34.00	158	158	0.28	MATH10	0.559	1998.36
University of North Carolina at Greensboro	2976	Pub	D2	MathStat	0	19.34	0	19	0.29	MATH10	0.559	1998.36
University of Missouri, Kansas City	2518	Pub	D2	MathStat	0	11.61	9	9	0.29	MATH10	0.559	1998.36
Auburn University, Main Campus	1009	Pub	R2	MathStat	34	34.00	22	22	0.29	MATH10	0.559	1998.36
University of Mississippi, Main Campus	2440	Pub	D1	MathStat	0	16.20	0	16	0.30	MATH10	0.559	1998.36
Montana State University	2532	Pub	D2	MathStat	0	20.02	44	44	0.30	MATH10	0.559	1998.36
Temple University	3371	Pub	R2	MathStat	51	51.00	66	66	0.30	MATH10	0.559	1998.36
East Texas State University, All Campuses	3565	Pub	D2	MathStat	0	11.61	0	12	0.31	MATH10	0.559	1998.36
University of Rhode Island	3414	Pub	R2	MathStat	0	17.65	0	18	0.31	MATH10	0.559	1998.36
North Carolina State University at Raleigh	2972	Pub	R1	MathStat	95	95.00	772	772	0.31	MATH10	0.559	1998.36
University of North Texas	3594	Pub	D1	MathStat	0	16.20	25	25	0.32	MATH10	0.559	1998.36
Florida Atlantic University	1481	Pub	D2	MathStat	0	9.98	0	10	0.32	MATH10	0.559	1998.36
University of Vermont	3696	Pub	D2	MathStat	0	21.88	59	59	0.32	MATH10	0.559	1998.36
Georgia State University	1574	Pub	D1	MathStat	0	38.38	12	12	0.33	MATH10	0.559	1998.36
University of South Florida	1537	Pub	D1	MathStat	29	29.00	127	127	0.34	MATH10	0.559	1998.36
University of Utah	3675	Pub	R1	MathStat	53	53.00	393	393	0.35	MATH10	0.559	1998.36
Utah State University	3677	Pub	R2	MathStat	0	16.93	31	31	0.35	MATH10	0.559	1998.36
Southern Illinois University-Carbondale	1758	Pub	R2	MathStat	31	31.00	26	26	0.36	MATH10	0.559	1998.36
University of Cincinnati, All Campuses	3125	Pub	R1	MathStat	30	30.00	88	88	0.36	MATH10	0.559	1998.36
University of Massachusetts at Amherst	2221	Pub	R2	MathStat	49	49.00	124	124	0.37	MATH10	0.559	1998.36
Cleveland State University	3032	Pub	D2	MathStat	0	23.47	13	13	0.37	MATH10	0.559	1998.36
University of Maryland Baltimore County	2105	Pub	D2	MathStat	0	17.97	76	76	0.37	MATH10	0.559	1998.36
University of Arizona	1083	Pub	R1	MathStat	46	46.00	406	406	0.37	MATH10	0.559	1998.36
University of Louisville	1999	Pub	D1	MathStat	0	30.21	38	38	0.37	MATH10	0.559	1998.36
Colorado School of Mines	1348	Pub	D2	MathStat	0	13.18	79	79	0.39	MATH10	0.559	1998.36
University of Southern Mississippi	2441	Pub	D1	MathStat	0	15.63	43	43	0.40	MATH10	0.559	1998.36

Table 5-A.5: Segmentation Array: Mathematics and Statistics

School	FICE	TOC	Carnegie Class	Academic Discipline	Faculty	Faculty (adjusted)	R&D Expenditures	R&D Exp (adjusted)	Factor Score	Segment	Segment RU Fraction	Segment Faculty
University of Arkansas, Main Campus	1108	Pub	D1	MathStat	0	23.95	36	36	0.40	MATH10	0.559	1998.36
Washington State University	3800	Pub	R2	MathStat	0	45.67	89	89	0.40	MATH10	0.559	1998.36
University of Missouri, Rolla	2517	Pub	D2	MathStat	17	17.00	71	71	0.40	MATH10	0.559	1998.36
Colorado State University	1350	Pub	R1	MathStat	45	45.00	380	380	0.41	MATH10	0.559	1998.36
University of Akron, All Campuses	3123	Pub	D1	MathStat	0	27.57	9	9	0.41	MATH10	0.559	1998.36
College of William and Mary	3705	Pub	D1	MathStat	0	18.56	230	230	0.42	MATH10	0.559	1998.36
Old Dominion University	3728	Pub	D2	MathStat	0	26.02	61	61	0.43	MATH10	0.559	1998.36
Portland State University	3216	Pub	D2	MathStat	0	29.21	0	29.212961	0.44	MATH10	0.559	1998.36
Georgia Institute of Technology, Main Campus	1569	Pub	R1	MathStat	41	41.00	512	512	0.44	MATH10	0.559	1998.36
New Mexico State University, All Campuses	2657	Pub	R1	MathStat	30	30.00	56	56	0.45	MATH10	0.559	1998.36
Illinois State University	1,692	Pub	D2	MathStat	0	38.77	3	3	0.46	MATH10	0.559	1998.36
Wayne State University	2329	Pub	R2	MathStat	46	46.00	164	164	0.49	MATH10	0.559	1998.36
Indiana State University, Terre Haute	9563	Pub	D2	MathStat	0	18.35	0	18	0.49	MATH10	0.559	1998.36
University of Nevada-Reno	2568	Pub	D2	MathStat	0	11.72	0	12	0.50	MATH10	0.559	1998.36
University of Maine at Orono	2053	Pub	D2	MathStat	0	26.68	64	64	0.51	MATH10	0.559	1998.36
West Virginia University	3827	Pub	R2	MathStat	0	37.00	32	32	0.51	MATH10	0.559	1998.36
University of Maryland at College Park	2103	Pub	R1	MathStat	173	173.00	420	420	0.52	MATH10	0.559	1998.36
North Dakota State University, All Campuses	9265	Pub	D2	MathStat	0	15.63	23	23	0.54	MATH10	0.559	1998.36
Louisiana Tech University	2008	Pub	D2	MathStat	0	22.67	31	31	0.55	MATH10	0.559	1998.36
University of Toledo	3131	Pub	D1	MathStat	0	26.37	5	5	0.56	MATH10	0.559	1998.36
University of South Dakota	3474	Pub	D2	MathStat	0	16.38	0	16	0.56	MATH10	0.559	1998.36
University of Idaho	1626	Pub	D2	MathStat	0	13.32	0	13	0.56	MATH10	0.559	1998.36
University of Hawaii at Manoa	1610	Pub	R1	MathStat	0	38.77	78	78	0.57	MATH10	0.559	1998.36
University of Alabama at Birmingham	1052	Pub	D2	MathStat	0	17.65	26	26	0.57	MATH10	0.559	1998.36
University of North Dakota, All Campuses	3005	Pub	D2	MathStat	0	17.90	0	18	0.57	MATH10	0.559	1998.36
University of Missouri, Saint Louis	2519	Pub	D2	MathStat	0	30.30	8	8	0.58	MATH10	0.559	1998.36
Mississippi State University	2423	Pub	R2	MathStat	0	33.13	76	76	0.60	MATH10	0.559	1998.36
Northern Arizona University	1082	Pub	D2	MathStat	0	22.79	30	30	0.60	MATH10	0.559	1998.36
University of New Orleans	2015	Pub	D2	MathStat	0	38.41	6	6	0.62	MATH10	0.559	1998.36
Tennessee Technological University	3523	Pub	D2	MathStat	0	20.22	0	20	0.62	MATH10	0.559	1998.36
SUNY College of Environmental Science and F	2851	Pub	D2	MathStat	0	3.85	0	4	0.75	MATH10	0.559	1998.36
Louisiana State University and Agric & Mech Co	2010	Pub	R1	MathStat	0 •		0 •		•	MATH10	0.559	1998.36
University of California-San Francisco	1319	Pub	R1	MathStat	0 •		0 •		•	MATH10	0.559	1998.36

Table 5-A.6: Segmentation Array: Economics

School	FICE	TOC	Carnegie Class	Academic Discipline	Faculty	Faculty (adjusted)	R&D Expenditures	R&D Exp (adjusted)	Factor Score	Segment	Segment RU Fraction	Segment Faculty
Johns Hopkins University	2077	Pri	R1	Economics	7	7.00	401	401	-5.00	ECON01	0.618	102.00
Cornell University, All Campuses	2711	Pri	R1	Economics	24	24.00	1,893	1,893	-3.53	ECON01	0.618	102.00
New School For Social Research	2780	Pri	D2	Economics	11	11.00	0	11	-3.37	ECON01	0.618	102.00
University of Notre Dame	1,840	Pri	D1	Economics	12	12.00	0	15	-1.73	ECON01	0.618	102.00
Stanford University	1305	Pri	R1	Economics	32	32.00	668	668	-1.69	ECON01	0.618	102.00
American University	1434	Pri	D1	Economics	16	16.00	119	119	-1.44	ECON01	0.618	102.00
University of Chicago	1774	Pri	R1	Economics	27	27.00	656	656	-1.38	ECON02	1.000	164.00
Columbia University, Main Campus	2707	Pri	R1	Economics	28	28.00	2,941	2,941	-1.38	ECON02	1.000	164.00
University of Rochester	2894	Pri	R1	Economics	15	15.00	236	236	-1.30	ECON02	1.000	164.00
Georgetown University	1445	Pri	R2	Economics	15	15.00	3	3	-1.22	ECON02	1.000	164.00
Duke University	2920	Pri	R1	Economics	22	22.00	123	123	-1.07	ECON02	1.000	164.00
Harvard University	2155	Pri	R1	Economics	34	34.00	1,783	1,783	-1.02	ECON02	1.000	164.00
Vanderbilt University	3535	Pri	R1	Economics	23	23.00	56	56	-0.97	ECON02	1.000	164.00
University of Pennsylvania	3378	Pri	R1	Economics	41	41.00	1,511	1,511	-0.90	ECON03	0.838	235.20
Brown University	3401	Pri	R2	Economics	15	15.00	225	225	-0.76	ECON03	0.838	235.20
George Washington University	1444	Pri	R2	Economics	24	24.00	225	225	-0.71	ECON03	0.838	235.20
New York University	2785	Pri	R1	Economics	29	29.00	850	850	-0.71	ECON03	0.838	235.20
Fordham University	2722	Pri	D1	Economics	14	14.00	0	17	-0.62	ECON03	0.838	235.20
Syracuse University, Main Campus	2882	Pri	R2	Economics	17	17.00	471	471	-0.60	ECON03	0.838	235.20
Washington University	2520	Pri	R1	Economics	20	20.00	115	115	-0.59	ECON03	0.838	235.20
Tufts University	2219	Pri	D1	Economics	0	12.33	28	28	-0.58	ECON03	0.838	235.20
Yale University	1426	Pri	R1	Economics	51	51.00	1,179	1,179	-0.54	ECON03	0.838	235.20
Catholic University of America	1437	Pri	D1	Economics	0	11.87	0	12	-0.49	ECON03	0.838	235.20
Boston College	2128	Pri	D1	Economics	21	21.00	424	424	-0.44	ECON04	0.470	680.52
Massachusetts Institute of Technology	2178	Pri	R1	Economics	53	53.00	1,815	1,815	-0.42	ECON04	0.470	680.52
Northwestern University	1739	Pri	R1	Economics	41	41.00	467	467	-0.32	ECON04	0.470	680.52
Boston University	2130	Pri	R1	Economics	38	38.00	281	281	-0.29	ECON04	0.470	680.52
University of San Francisco	1325	Pri	D2	Economics	0	5.20	0	5	-0.26	ECON04	0.470	680.52
Northeastern University	2199	Pri	D2	Economics	0	19.16	292	292	-0.16	ECON04	0.470	680.52
University of Denver	1371	Pri	D1	Economics	0	13.37	2,470	2,470	-0.04	ECON04	0.470	680.52
Southern Methodist University	3613	Pri	D2	Economics	13	13.00	43	43	-0.04	ECON04	0.470	680.52
Rice University	3604	Pri	D1	Economics	12	12.00	16	16	0.00	ECON04	0.470	680.52
Howard University	1448	Pri	R1	Economics	0	14.27	2	2	0.05	ECON04	0.470	680.52
Princeton University	2627	Pri	R1	Economics	41	41.00	834	834	0.10	ECON04	0.470	680.52
University of Southern California	1328	Pri	R1	Economics	26	26.00	1,451	1,451	0.11	ECON04	0.470	680.52
Rensselaer Polytechnic Institute	2803	Pri	R2	Economics	0	6.74	0	7	0.29	ECON04	0.470	680.52
Tulane University of Louisiana	2029	Pri	R2	Economics	11	11.00	0	15	0.30	ECON04	0.470	680.52
Brandeis University	2133	Pri	R2	Economics	0	7.34	18	18	0.31	ECON04	0.470	680.52
Brigham Young University, Main Campus	3670	Pri	D1	Economics	0	15.96	6	6	0.32	ECON04	0.470	680.52
Clark University	2139	Pri	D2	Economics	9	9.00	0	7	0.37	ECON04	0.470	680.52
Dartmouth College	2573	Pri	D2	Economics	0	13.93	19	19	0.46	ECON04	0.470	680.52
Case Western Reserve University	3024	Pri	R1	Economics	10	10.00	82	82	0.48	ECON04	0.470	680.52
Columbia University, Teachers College	3979	Pri	D1	Economics	0	1.90	6	6	0.52	ECON04	0.470	680.52
University of Miami	1536	Pri	R1	Economics	0	11.78	8	8	0.53	ECON04	0.470	680.52

Table 5-A.6: Segmentation Array: Economics

School	FICE	TOC	Carnegie Class	Academic Discipline	Faculty	Faculty (adjusted)	R&D Expenditures	R&D Exp (adjusted)	Factor Score	Segment	Segment RU Fraction	Segment Faculty
Claremont Univ Center & Graduate School	1169	Pri	D1	Economics	19	19.00	0	4	0.59	ECON04	0.470	680.52
Union Institute	10923	Pri	D1	Economics	0	1.77	0	2	0.64	ECON04	0.470	680.52
Texas Christian University	3636	Pri	D2	Economics	0	5.20	23	23	0.64	ECON04	0.470	680.52
Carnegie Mellon University	3242	Pri	R1	Economics	17	17.00	711	711	0.67	ECON04	0.470	680.52
Yeshiva University	2903	Pri	R1	Economics	0	5.39	0	5	0.70	ECON04	0.470	680.52
Clark Atlanta University	1559	Pri	D2	Economics	0	5.78	146	146	0.74	ECON04	0.470	680.52
California Institute of Technology	1131	Pri	R1	Economics	19	19.00	243	243	0.78	ECON04	0.470	680.52
Florida Institute of Technology	1469	Pri	D2	Economics	0	13.05	0	13	0.81	ECON04	0.470	680.52
Marquette University	3863	Pri	D1	Economics	0	11.62	0	12	0.82	ECON04	0.470	680.52
Saint John's University New York	2823	Pri	D1	Economics	0	25.61	0	26	0.85	ECON04	0.470	680.52
Emory University	1564	Pri	R2	Economics	0	18.64	0	19	0.86	ECON04	0.470	680.52
Lehigh University	3289	Pri	D1	Economics	0	12.58	0	13	0.88	ECON04	0.470	680.52
Drake University	1860	Pri	D2	Economics	0	6.66	1	1	0.88	ECON04	0.470	680.52
Duquesne University	3258	Pri	D2	Economics	0	7.34	63	63	0.91	ECON04	0.470	680.52
Loyola University of Chicago	1710	Pri	D1	Economics	0	9.35	0	9	0.92	ECON04	0.470	680.52
Pepperdine University	1264	Pri	D2	Economics	0	6.97	0	7	0.93	ECON04	0.470	680.52
Saint Louis University, Main Campus	2506	Pri	D1	Economics	0	9.99	0	10	0.94	ECON04	0.470	680.52
Adelphi University	2666	Pri	D2	Economics	0	4.42	0	4	0.95	ECON04	0.470	680.52
Illinois Institute of Technology	1691	Pri	D1	Economics	0	14.46	24	24	0.95	ECON04	0.470	680.52
Hofstra University	2732	Pri	D2	Economics	0	12.31	14	14	0.97	ECON04	0.470	680.52
Baylor University	6987	Pri	D2	Economics	0	13.37	0	13	0.97	ECON04	0.470	680.52
Loma Linda University	1218	Pri	D2	Economics	0	14.77	0	15	1.01	ECON04	0.470	680.52
Clarkson University	2699	Pri	D2	Economics	0	8.14	0	8	1.02	ECON04	0.470	680.52
University of Tulsa	3185	Pri	D2	Economics	0	8.14	6	6	1.02	ECON04	0.470	680.52
Stevens Institute of Technology	2639	Pri	D2	Economics	0	9.30	45	45	1.02	ECON04	0.470	680.52
Drexel University	3256	Pri	D2	Economics	0	9.11	0	9	1.03	ECON04	0.470	680.52
Andrews University	2238	Pri	D2	Economics	0	1.90	0	2	1.03	ECON04	0.470	680.52
Biola University	1122	Pri	D2	Economics	0	1.90	0	2	1.03	ECON04	0.470	680.52
Hahnemann University	3271	Pri	D2	Economics	0	0.98	0	1	1.03	ECON04	0.470	680.52
Nova University	1509	Pri	D1	Economics	0	2.11	0	2	1.09	ECON04	0.470	680.52
Polytechnic University	2796	Pri	D2	Economics	0 •		11	11	•	ECON04	0.470	680.52
Rockefeller University	2807	Pri	R1	Economics	0 •		0 •		•	ECON04	0.470	680.52
Purdue University, Main Campus	1825	Pub	R1	Economics	21	21.00	3,765	3,765	-3.54	ECON05	1.000	100.00
University of California-Berkeley	1312	Pub	R1	Economics	26	26.00	103	103	-2.69	ECON05	1.000	100.00
Texas A & M University, Main Campus	10366	Pub	R1	Economics	24	24.00	726	726	-2.62	ECON05	1.000	100.00
Michigan State University	2290	Pub	R1	Economics	29	29.00	3,031	3,031	-2.27	ECON05	1.000	100.00
University of Minnesota at Twin Cities	3969	Pub	R1	Economics	33	33.00	1,915	1,915	-2.25	ECON06	1.000	160.00
University of Wisconsin-Madison	3895	Pub	R1	Economics	45	45.00	3,367	3,367	-2.18	ECON06	1.000	160.00
University of California-Los Angeles	1315	Pub	R1	Economics	27	27.00	172	172	-1.75	ECON06	1.000	160.00
University of Missouri, Columbia	2516	Pub	R1	Economics	15	15.00	1,637	1,637	-1.71	ECON06	1.000	160.00
Ohio State University, Main Campus	6883	Pub	R1	Economics	24	24.00	1,227	1,227	-1.62	ECON06	1.000	160.00
University of Cincinnati, All Campuses	3125	Pub	R1	Economics	16	16.00	8	8	-1.33	ECON06	1.000	160.00
University of Colorado at Boulder	1370	Pub	R1	Economics	20	20.00	190	190	-1.29	ECON07	1.000	199.00
SUNY at Stony Brook, All Campuses	2838	Pub	R1	Economics	18	18.00	65	65	-1.24	ECON07	1.000	199.00

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Table 5-A.6: Segmentation Array: Economics

School	FICE	TOC	Carnegie Class	Academic Discipline	Faculty	Faculty (adjusted)	R&D Expenditures	R&D Exp (adjusted)	Factor Score	Segment	Segment RU Fraction	Segment Faculty
Virginia Polytechnic Institute and State Univ	3754	Pub	R1	Economics	15	15.00	1,124	1,124	-1.17	ECON07	1.000	199.00
University of Kentucky, Main Campus	1989	Pub	R1	Economics	17	17.00	273	273	-1.17	ECON07	1.000	199.00
Iowa State University	1869	Pub	R2	Economics	32	32.00	1,979	1,979	-1.16	ECON07	1.000	199.00
Indiana University at Bloomington	1809	Pub	R1	Economics	21	21.00	405	405	-1.12	ECON07	1.000	199.00
University of Illinois at Urbana-Champaign	1775	Pub	R1	Economics	56	56.00	2,764	2,764	-0.99	ECON07	1.000	199.00
University of Nebraska at Lincoln	2565	Pub	R2	Economics	20	20.00	1,020	1,020	-0.99	ECON07	1.000	199.00
University of Maryland at College Park	2103	Pub	R1	Economics	40	40.00	1,125	1,125	-0.99	ECON08	0.837	257.91
Washington State University	3800	Pub	R2	Economics	19	19.00	12	12	-0.93	ECON08	0.837	257.91
University of Florida	1535	Pub	R1	Economics	20	20.00	459	459	-0.89	ECON08	0.837	257.91
Pennsylvania State U, Main Campus	6965	Pub	R1	Economics	24	24.00	1,842	1,842	-0.87	ECON08	0.837	257.91
University of Hawaii at Manoa	1610	Pub	R1	Economics	21	21.00	484	484	-0.81	ECON08	0.837	257.91
Rutgers, the State University at New Brunswick	6964	Pub	R1	Economics	35	35.00	952	952	-0.80	ECON08	0.837	257.91
University of Pittsburgh Main Campus	3379	Pub	R1	Economics	23	23.00	37	37	-0.79	ECON08	0.837	257.91
University of Connecticut, Main Campus	29013	Pub	R1	Economics	19	19.00	203	203	-0.60	ECON08	0.837	257.91
CUNY Graduate School and University Center	4063	Pub	D1	Economics	13	13.00	1	1	-0.59	ECON08	0.837	257.91
SUNY at Buffalo, Main Campus	2837	Pub	R2	Economics	0	14.91	142	142	-0.49	ECON08	0.837	257.91
University of California-Riverside	1316	Pub	D1	Economics	10	10.00	126	126	-0.47	ECON08	0.837	257.91
University of Arkansas, Main Campus	1108	Pub	D1	Economics	19	19.00	1,728	1,728	-0.45	ECON08	0.837	257.91
Utah State University	3677	Pub	R2	Economics	0	16.65	1,267	1,267	-0.42	ECON09	0.927	363.30
University of North Carolina at Chapel Hill	2974	Pub	R1	Economics	26	26.00	230	230	-0.40	ECON09	0.927	363.30
University of Massachusetts at Amherst	2221	Pub	R2	Economics	25	25.00	244	244	-0.40	ECON09	0.927	363.30
University of California-Santa Barbara	1320	Pub	R2	Economics	25	25.00	8	8	-0.36	ECON09	0.927	363.30
SUNY at Albany	2835	Pub	R2	Economics	16	16.00	57	57	-0.36	ECON09	0.927	363.30
University of Washington	3798	Pub	R1	Economics	30	30.00	156	156	-0.32	ECON09	0.927	363.30
University of Michigan at Ann Arbor	9092	Pub	R1	Economics	45	45.00	882	882	-0.29	ECON09	0.927	363.30
Colorado School of Mines	1348	Pub	D2	Economics	0	10.43	0	10	-0.24	ECON09	0.927	363.30
Kansas State University of Agriculture and App	1928	Pub	R2	Economics	0	27.87	412	412	-0.23	ECON09	0.927	363.30
University of Texas at Austin	3658	Pub	R1	Economics	29	29.00	991	991	-0.21	ECON09	0.927	363.30
University of Georgia	1598	Pub	R1	Economics	0	27.84	2,962	2,962	-0.21	ECON09	0.927	363.30
Northern Illinois University	1737	Pub	D1	Economics	16	16.00	210	210	-0.17	ECON09	0.927	363.30
University of Arizona	1083	Pub	R1	Economics	0	23.99	1,826	1,826	-0.17	ECON09	0.927	363.30
Oregon State University	3210	Pub	R1	Economics	0	27.52	1,066	1,066	-0.13	ECON09	0.927	363.30
University of Kansas, Main Campus	1948	Pub	R2	Economics	17	17.00	161	161	-0.11	ECON09	0.927	363.30
Oklahoma State University, All Campuses	3170	Pub	R2	Economics	40	40.00	318	318	-0.10	ECON10	0.484	1374.67
University of California-San Diego	1317	Pub	R1	Economics	20	20.00	156	156	-0.05	ECON10	0.484	1374.67
University of Virginia, Main Campus	6968	Pub	R1	Economics	30	30.00	574	574	-0.01	ECON10	0.484	1374.67
University of Oklahoma, Norman Campus	3184	Pub	R2	Economics	15	15.00	916	916	0.00	ECON10	0.484	1374.67
Southern Illinois University-Carbondale	1758	Pub	R2	Economics	13	13.00	78	78	0.01	ECON10	0.484	1374.67
University of New Mexico, All Campuses	10313	Pub	R1	Economics	0	14.91	484	484	0.06	ECON10	0.484	1374.67
West Virginia University	3827	Pub	R2	Economics	24	24.00	813	813	0.06	ECON10	0.484	1374.67
Florida State University	1489	Pub	R2	Economics	16	16.00	197	197	0.07	ECON10	0.484	1374.67
University of Tennessee at Knoxville	3530	Pub	R1	Economics	0	19.98	0	20	0.09	ECON10	0.484	1374.67
University of Missouri, Kansas City	2518	Pub	D2	Economics	0	5.94	9	9	0.13	ECON10	0.484	1374.67
University of California-Davis	1313	Pub	R1	Economics	45	45.00	1,232	1,232	0.16	ECON10	0.484	1374.67

Table 5-A.6: Segmentation Array: Economics

School	FICE	TOC	Carnegie Class	Academic Discipline	Faculty	Faculty (adjusted)	R&D Expenditures	R&D Exp (adjusted)	Factor Score	Segment	Segment RU Fraction	Segment Faculty
North Carolina State University at Raleigh	2972	Pub	R1	Economics	44	44.00	158	158	0.16	ECON10	0.484	1374.67
Mississippi State University	2423	Pub	R2	Economics	0	27.99	1,332	1,332	0.19	ECON10	0.484	1374.67
University of Rhode Island	3414	Pub	R2	Economics	0	14.04	111	111	0.22	ECON10	0.484	1374.67
University of Utah	3675	Pub	R1	Economics	21	21.00	0	19	0.22	ECON10	0.484	1374.67
Georgia State University	1574	Pub	D1	Economics	20	20.00	207	207	0.24	ECON10	0.484	1374.67
University of Oregon	3223	Pub	R2	Economics	17	17.00	250	250	0.24	ECON10	0.484	1374.67
SUNY at Binghamton	2836	Pub	D1	Economics	20	20.00	133	133	0.26	ECON10	0.484	1374.67
University of Wisconsin-Milwaukee	3896	Pub	D1	Economics	17	17.00	84	84	0.29	ECON10	0.484	1374.67
College of William and Mary	3705	Pub	D1	Economics	0	10.65	14	14	0.30	ECON10	0.484	1374.67
Wayne State University	2329	Pub	R2	Economics	21	21.00	201	201	0.32	ECON10	0.484	1374.67
University of Texas at Dallas	9741	Pub	D2	Economics	0	5.23	18	18	0.33	ECON10	0.484	1374.67
University of Iowa	1892	Pub	R1	Economics	23	23.00	99	99	0.33	ECON10	0.484	1374.67
Colorado State University	1350	Pub	R1	Economics	39	39.00	499	499	0.34	ECON10	0.484	1374.67
University of Alabama	1051	Pub	D1	Economics	0	9.26	105	105	0.36	ECON10	0.484	1374.67
Clemson University	3425	Pub	D1	Economics	0	26.01	101	101	0.36	ECON10	0.484	1374.67
Texas Tech University	3644	Pub	D1	Economics	0	15.30	11	11	0.41	ECON10	0.484	1374.67
Illinois State University	1692	Pub	D2	Economics	0	17.45	20	20	0.42	ECON10	0.484	1374.67
Western Michigan University	2330	Pub	D1	Economics	0	13.87	6	6	0.44	ECON10	0.484	1374.67
University of Delaware	1431	Pub	R2	Economics	0	20.71	154	154	0.45	ECON10	0.484	1374.67
University of Houston-University Park	3652	Pub	D1	Economics	0	23.42	238	238	0.47	ECON10	0.484	1374.67
Georgia Institute of Technology, Main Campus	1569	Pub	R1	Economics	0	30.29	3,727	3,727	0.48	ECON10	0.484	1374.67
Indiana State University, Terre Haute	9563	Pub	D2	Economics	0	10.43	0	10	0.51	ECON10	0.484	1374.67
University of California-Santa Cruz	1321	Pub	D1	Economics	0	9.35	34	34	0.52	ECON10	0.484	1374.67
Temple University	3371	Pub	R2	Economics	0	25.27	150	150	0.52	ECON10	0.484	1374.67
New Mexico State University, All Campuses	2657	Pub	R1	Economics	0	28.15	35	35	0.52	ECON10	0.484	1374.67
Arizona State University	1081	Pub	R2	Economics	0	17.09	372	372	0.55	ECON10	0.484	1374.67
North Dakota State University, All Campuses	9265	Pub	D2	Economics	0	23.31	0	23	0.56	ECON10	0.484	1374.67
University of South Carolina at Columbia	3448	Pub	R2	Economics	16	16.00	396	396	0.56	ECON10	0.484	1374.67
University of Vermont	3696	Pub	D2	Economics	0	14.42	130	130	0.57	ECON10	0.484	1374.67
University of Maryland Baltimore County	2105	Pub	D2	Economics	0	12.50	0	12	0.58	ECON10	0.484	1374.67
University of North Texas	3594	Pub	D1	Economics	0	9.26	158	158	0.59	ECON10	0.484	1374.67
University of Maine at Orono	2053	Pub	D2	Economics	0	17.85	673	673	0.60	ECON10	0.484	1374.67
University of Wyoming	3932	Pub	R2	Economics	0	23.30	851	851	0.62	ECON10	0.484	1374.67
Portland State University	3216	Pub	D2	Economics	0	12.91	0	13	0.63	ECON10	0.484	1374.67
Auburn University, Main Campus	1009	Pub	R2	Economics	0	31.92	3	3	0.63	ECON10	0.484	1374.67
Ohio University, All Campuses	3100	Pub	D1	Economics	0	16.61	55	55	0.65	ECON10	0.484	1374.67
University of Illinois at Chicago	1776	Pub	R1	Economics	0	15.22	23	23	0.66	ECON10	0.484	1374.67
Miami University, All Campuses	7104	Pub	D1	Economics	0	18.82	11	11	0.67	ECON10	0.484	1374.67
Louisiana Tech University	2008	Pub	D2	Economics	0	9.26	36	36	0.67	ECON10	0.484	1374.67
University of Nevada-Reno	2568	Pub	D2	Economics	0	8.64	222	222	0.68	ECON10	0.484	1374.67
University of Idaho	1626	Pub	D2	Economics	0	20.97	755	755	0.68	ECON10	0.484	1374.67
University of New Hampshire, Main Campus	2589	Pub	D2	Economics	0	26.49	5	5	0.69	ECON10	0.484	1374.67
University of Montana	2536	Pub	D1	Economics	0	10.65	244	244	0.71	ECON10	0.484	1374.67
Florida Atlantic University	1481	Pub	D2	Economics	0	8.76	33	33	0.71	ECON10	0.484	1374.67

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Table 5-A.6: Segmentation Array: Economics

School	FICE	TOC	Carnegie Class	Academic Discipline	Faculty	Faculty (adjusted)	R&D Expenditures	R&D Exp (adjusted)	Factor Score	Segment	Segment RU Fraction	Segment Faculty
University of Texas at Arlington	3656	Pub	D2	Economics	0	14.71	0	15	0.73	ECON10	0.484	1374.67
Ball State University	1786	Pub	D1	Economics	0	9.86	7	7	0.73	ECON10	0.484	1374.67
Cleveland State University	3032	Pub	D2	Economics	0	12.34	0	12	0.74	ECON10	0.484	1374.67
University of Akron, All Campuses	3123	Pub	D1	Economics	0	11.37	0	11	0.74	ECON10	0.484	1374.67
University of North Carolina at Greensboro	2976	Pub	D2	Economics	0	12.07	3	3	0.76	ECON10	0.484	1374.67
University of Missouri, Rolla	2517	Pub	D2	Economics	0	6.66	0	7	0.76	ECON10	0.484	1374.67
University of North Dakota, All Campuses	3005	Pub	D2	Economics	0	9.77	82	82	0.78	ECON10	0.484	1374.67
Montana State University	2532	Pub	D2	Economics	0	13.41	423	423	0.79	ECON10	0.484	1374.67
Bowling Green State University, All Campuses	3018	Pub	D1	Economics	0	13.57	39	39	0.79	ECON10	0.484	1374.67
Memphis State University	3509	Pub	D1	Economics	0	15.47	0	15	0.80	ECON10	0.484	1374.67
Old Dominion University	3728	Pub	D2	Economics	0	15.30	33	33	0.83	ECON10	0.484	1374.67
University of Missouri, Saint Louis	2519	Pub	D2	Economics	0	13.08	4	4	0.85	ECON10	0.484	1374.67
University of Toledo	3131	Pub	D1	Economics	0	10.60	27	27	0.86	ECON10	0.484	1374.67
University of Mississippi, Main Campus	2440	Pub	D1	Economics	0	14.97	134	134	0.86	ECON10	0.484	1374.67
Middle Tennesse State University	3510	Pub	D2	Economics	0	9.86	0	10	0.87	ECON10	0.484	1374.67
University of New Orleans	2015	Pub	D2	Economics	0	17.04	166	166	0.88	ECON10	0.484	1374.67
East Texas State University, All Campuses	3565	Pub	D2	Economics	0	7.34	0	7	0.91	ECON10	0.484	1374.67
Virginia Commonwealth University	3735	Pub	R2	Economics	0	12.58	2	2	0.93	ECON10	0.484	1374.67
University of South Florida	1537	Pub	D1	Economics	0	14.95	104	104	0.93	ECON10	0.484	1374.67
Kent State University, All Campuses	3051	Pub	D1	Economics	0	14.04	23	23	0.95	ECON10	0.484	1374.67
University of Southern Mississippi	2441	Pub	D1	Economics	0	9.45	0	9	0.97	ECON10	0.484	1374.67
Idaho State University	1620	Pub	D2	Economics	0	4.43	0	4	0.97	ECON10	0.484	1374.67
University of Northern Colorado	1349	Pub	D1	Economics	0	5.20	0	5	0.97	ECON10	0.484	1374.67
University of Alabama at Birmingham	1052	Pub	D2	Economics	0	7.34	0	7	0.98	ECON10	0.484	1374.67
University of South Dakota	3474	Pub	D2	Economics	0	5.20	18	18	1.01	ECON10	0.484	1374.67
University of Louisville	1999	Pub	D1	Economics	0	11.06	0	11	1.01	ECON10	0.484	1374.67
SUNY College of Environmental Science and F	2851	Pub	D2	Economics	0	3.63	0	4	1.02	ECON10	0.484	1374.67
Tennessee Technological University	3523	Pub	D2	Economics	0	7.71	5	5	1.03	ECON10	0.484	1374.67
Northern Arizona University	1082	Pub	D2	Economics	0	4.42	1	1	1.04	ECON10	0.484	1374.67
Louisiana State University and Agric & Mech Co	2010	Pub	R1	Economics	0 •		0 •		•	ECON10	0.484	1374.67
Texas Woman's University	3646	Pub	D1	Economics	0 •		0 •		•	ECON10	0.484	1374.67
University of California-Irvine	1314	Pub	R1	Economics	0 •		0 •		•	ECON10	0.484	1374.67
University of California-San Francisco	1319	Pub	R1	Economics	0 •		0 •		•	ECON10	0.484	1374.67

Table 5-A.7: Segmentation Array: Psychology

School	FICE	TOC	Carnegie Class	Academic Discipline	Faculty	Faculty (adjusted)	R&D Expenditures	R&D Exp (adjusted)	Factor Score	Segment	Segment RU Fraction	Segment Faculty
Hofstra University	2732	Pri	D2	PSYCH	7	7.00	0	25	-9.28	PSYC01	0.501	107.74
Adelphi University	2666	Pri	D2	PSYCH	13	13.00	0	26	-4.44	PSYC01	0.501	107.74
Yeshiva University	2903	Pri	R1	PSYCH	16	16.00	0	37	-3.55	PSYC01	0.501	107.74
New School For Social Research	2780	Pri	D2	PSYCH	17	17.00	228	228	-2.82	PSYC01	0.501	107.74
New York University	2785	Pri	R1	PSYCH	38	38.00	897	897	-2.65	PSYC01	0.501	107.74
Union Institute	10923	Pri	D1	PSYCH	0	6.47	0	6	-2.37	PSYC01	0.501	107.74
Florida Institute of Technology	1469	Pri	D2	PSYCH	0	10.27	1	1	-1.83	PSYC01	0.501	107.74
Columbia University, Main Campus	2707	Pri	R1	PSYCH	18	18.00	491	491	-1.76	PSYC02	0.261	257.15
Nova University	1509	Pri	D1	PSYCH	0	11.47	29	29	-1.45	PSYC02	0.261	257.15
Pepperdine University	1264	Pri	D2	PSYCH	0	15.31	0	15	-1.04	PSYC02	0.261	257.15
Catholic University of America	1437	Pri	D1	PSYCH	19	19.00	108	108	-0.95	PSYC02	0.261	257.15
Saint John's University New York	2823	Pri	D1	PSYCH	0	19.42	0	19	-0.90	PSYC02	0.261	257.15
George Washington University	1444	Pri	R2	PSYCH	19	19.00	170	170	-0.90	PSYC02	0.261	257.15
Illinois Institute of Technology	1691	Pri	D1	PSYCH	17	17.00	242	242	-0.86	PSYC02	0.261	257.15
Boston College	2128	Pri	D1	PSYCH	0	16.53	164	164	-0.82	PSYC02	0.261	257.15
University of San Francisco	1325	Pri	D2	PSYCH	0	6.42	0	6	-0.74	PSYC02	0.261	257.15
Fordham University	2722	Pri	D1	PSYCH	30	30.00	54	54	-0.69	PSYC02	0.261	257.15
Vanderbilt University	3535	Pri	R1	PSYCH	30	30.00	600	600	-0.67	PSYC02	0.261	257.15
Brigham Young University, Main Campus	3670	Pri	D1	PSYCH	18	18.00	11	11	-0.60	PSYC02	0.261	257.15
Columbia University, Teachers College	3979	Pri	D1	PSYCH	37	37.00	248	248	-0.51	PSYC02	0.261	257.15
Biola University	1122	Pri	D2	PSYCH	0	16.07	0	16	-0.51	PSYC03	0.780	314.30
Case Western Reserve University	3024	Pri	R1	PSYCH	13	13.00	210	210	-0.50	PSYC03	0.780	314.30
Syracuse University, Main Campus	2882	Pri	R2	PSYCH	29	29.00	325	325	-0.46	PSYC03	0.780	314.30
Johns Hopkins University	2077	Pri	R1	PSYCH	15	15.00	1,131	1,131	-0.36	PSYC03	0.780	314.30
Northwestern University	1739	Pri	R1	PSYCH	28	28.00	948	948	-0.36	PSYC03	0.780	314.30
University of Rochester	2894	Pri	R1	PSYCH	28	28.00	1,199	1,199	-0.34	PSYC03	0.780	314.30
University of Notre Dame	1840	Pri	D1	PSYCH	13	13.00	98	98	-0.34	PSYC03	0.780	314.30
Cornell University, All Campuses	2711	Pri	R1	PSYCH	34	34.00	2,280	2,280	-0.26	PSYC03	0.780	314.30
University of Southern California	1328	Pri	R1	PSYCH	33	33.00	2,383	2,383	-0.18	PSYC03	0.780	314.30
Baylor University	6967	Pri	D2	PSYCH	8	8.00	10	10	-0.17	PSYC03	0.780	314.30
Harvard University	2155	Pri	R1	PSYCH	27	27.00	1,785	1,785	-0.15	PSYC03	0.780	314.30
Saint Louis University, Main Campus	2506	Pri	D1	PSYCH	20	20.00	116	116	-0.14	PSYC03	0.780	314.30
Boston University	2130	Pri	R1	PSYCH	38	38.00	166	166	-0.13	PSYC03	0.780	314.30
Duquesne University	3258	Pri	D2	PSYCH	0	12.24	0	12	-0.12	PSYC03	0.780	314.30
University of Miami	1536	Pri	R1	PSYCH	19	19.00	222	222	-0.08	PSYC04	0.598	809.28
Stanford University	1305	Pri	R1	PSYCH	26	26.00	2,208	2,208	-0.04	PSYC04	0.598	809.28
Tulane University of Louisiana	2029	Pri	R2	PSYCH	17	17.00	206	206	-0.01	PSYC04	0.598	809.28
Loyola University of Chicago	1710	Pri	D1	PSYCH	37	37.00	285	285	0.06	PSYC04	0.598	809.28
Emory University	1564	Pri	R2	PSYCH	20	20.00	65	65	0.08	PSYC04	0.598	809.28
American University	1434	Pri	D1	PSYCH	0	18.43	57	57	0.09	PSYC04	0.598	809.28
Tufts University	2219	Pri	D1	PSYCH	0	15.49	217	217	0.13	PSYC04	0.598	809.28
University of Denver	1371	Pri	D1	PSYCH	30	30.00	853	853	0.19	PSYC04	0.598	809.28
Duke University	2920	Pri	R1	PSYCH	33	33.00	602	602	0.20	PSYC04	0.598	809.28
Princeton University	2627	Pri	R1	PSYCH	21	21.00	1,266	1,266	0.27	PSYC04	0.598	809.28

Table 5-A.7: Segmentation Array: Psychology

School	FICE	TOC	Carnegie Class	Academic Discipline	Faculty	Faculty (adjusted)	R&D Expenditures	R&D Exp (adjusted)	Factor Score	Segment	Segment RU Fraction	Segment Faculty
Claremont Univ Center & Graduate School	1169	Pri	D1	PSYCH	21	21.00	33	33	0.28	PSYC04	0.598	809.28
Carnegie Mellon University	3242	Pri	R1	PSYCH	17	17.00	1,093	1,093	0.28	PSYC04	0.598	809.28
Hahnemann University	3271	Pri	D2	PSYCH	0	16.64	365	365	0.29	PSYC04	0.598	809.28
Howard University	1448	Pri	R1	PSYCH	0	15.51	29	29	0.31	PSYC04	0.598	809.28
Clark Atlanta University	1559	Pri	D2	PSYCH	0	4.72	0	5	0.33	PSYC04	0.598	809.28
Washington University	2520	Pri	R1	PSYCH	26	26.00	738	738	0.35	PSYC04	0.598	809.28
Clark University	2139	Pri	D2	PSYCH	16	16.00	218	218	0.36	PSYC04	0.598	809.28
Texas Christian University	3636	Pri	D2	PSYCH	15	15.00	100	100	0.36	PSYC04	0.598	809.28
Stevens Institute of Technology	2639	Pri	D2	PSYCH	0	10.84	352	352	0.36	PSYC04	0.598	809.28
Marquette University	3863	Pri	D1	PSYCH	0	12.24	0	12	0.42	PSYC04	0.598	809.28
Yale University	1426	Pri	R1	PSYCH	49	49.00	1,243	1,243	0.44	PSYC04	0.598	809.28
Northeastern University	2199	Pri	D2	PSYCH	16	16.00	523	523	0.44	PSYC04	0.598	809.28
Southern Methodist University	3613	Pri	D2	PSYCH	0	14.39	116	116	0.49	PSYC04	0.598	809.28
Rensselaer Polytechnic Institute	2803	Pri	R2	PSYCH	0	9.45	42	42	0.55	PSYC04	0.598	809.28
University of Chicago	1774	Pri	R1	PSYCH	60	60.00	858	858	0.63	PSYC04	0.598	809.28
Drake University	1860	Pri	D2	PSYCH	0	8.64	4	4	0.63	PSYC04	0.598	809.28
Brown University	3401	Pri	R2	PSYCH	16	16.00	500	500	0.65	PSYC04	0.598	809.28
California Institute of Technology	1131	Pri	R1	PSYCH	0	2.20	0	2	0.68	PSYC04	0.598	809.28
Rice University	3604	Pri	D1	PSYCH	9	9.00	93	93	0.69	PSYC04	0.598	809.28
University of Pennsylvania	3378	Pri	R1	PSYCH	40	40.00	1,142	1,142	0.70	PSYC04	0.598	809.28
Dartmouth College	2573	Pri	D2	PSYCH	0	19.75	238	238	0.73	PSYC04	0.598	809.28
University of Tulsa	3185	Pri	D2	PSYCH	0	10.26	4	4	0.75	PSYC04	0.598	809.28
Rockefeller University	2807	Pri	R1	PSYCH	0	35.27	3,760	3,760	0.78	PSYC04	0.598	809.28
Brandeis University	2133	Pri	R2	PSYCH	14	14.00	283	283	0.79	PSYC04	0.598	809.28
Lehigh University	3289	Pri	D1	PSYCH	0	9.45	12	12	0.85	PSYC04	0.598	809.28
Loma Linda University	1218	Pri	D2	PSYCH	0	20.03	417	417	0.85	PSYC04	0.598	809.28
Massachusetts Institute of Technology	2178	Pri	R1	PSYCH	53	53.00	2,572	2,572	0.95	PSYC04	0.598	809.28
Georgetown University	1445	Pri	R2	PSYCH	0	10.40	0	10	0.98	PSYC04	0.598	809.28
Andrews University	2238	Pri	D2	PSYCH	0	10.40	0	10	1.04	PSYC04	0.598	809.28
Drexel University	3256	Pri	D2	PSYCH	0	6.38	81	81	1.05	PSYC04	0.598	809.28
Clarkson University	2699	Pri	D2	PSYCH	0	3.80	0	4	1.08	PSYC04	0.598	809.28
Polytechnic University	2796	Pri	D2	PSYCH	0 •		0 •		•	PSYC04	0.598	809.28
University of Wisconsin-Madison	3895	Pub	R1	PSYCH	36	36.00	6,232	6,232	-1.40	PSYC05	0.826	379.00
University of Tennessee at Knoxville	3530	Pub	R1	PSYCH	27	27.00	0	41	-0.98	PSYC05	0.826	379.00
University of Texas at Austin	3658	Pub	R1	PSYCH	46	46.00	1,494	1,494	-0.90	PSYC05	0.826	379.00
University of Georgia	1598	Pub	R1	PSYCH	38	38.00	842	842	-0.79	PSYC05	0.826	379.00
University of Southern Mississippi	2441	Pub	D1	PSYCH	17	17.00	4	4	-0.66	PSYC05	0.826	379.00
University of Wisconsin-Milwaukee	3896	Pub	D1	PSYCH	18	18.00	129	129	-0.65	PSYC05	0.826	379.00
University of Kentucky, Main Campus	1989	Pub	R1	PSYCH	21	21.00	0	42	-0.62	PSYC05	0.826	379.00
Western Michigan University	2330	Pub	D1	PSYCH	20	20.00	1	1	-0.61	PSYC05	0.826	379.00
Temple University	3371	Pub	R2	PSYCH	40	40.00	184	184	-0.59	PSYC05	0.826	379.00
University of Mississippi, Main Campus	2440	Pub	D1	PSYCH	11	11.00	72	72	-0.58	PSYC05	0.826	379.00
University of Minnesota at Twin Cities	3969	Pub	R1	PSYCH	58	58.00	3,907	3,907	-0.57	PSYC05	0.826	379.00
Ohio State University, Main Campus	6883	Pub	R1	PSYCH	47	47.00	733	733	-0.55	PSYC05	0.826	379.00

Table 5-A.7: Segmentation Array: Psychology

School	FICE	TOC	Carnegie Class	Academic Discipline	Faculty	Faculty (adjusted)	R&D Expenditures	R&D Exp (adjusted)	Factor Score	Segment	Segment RU Fraction	Segment Faculty
University of North Texas	3594	Pub	D1	PSYCH	23	23.00	0	24	-0.52	PSYC06	0.897	341.00
University of Nebraska at Lincoln	2565	Pub	R2	PSYCH	21	21.00	308	308	-0.52	PSYC06	0.897	341.00
Texas Woman's University	3646	Pub	D1	PSYCH	12	12.00	11	11	-0.49	PSYC06	0.897	341.00
University of Missouri, Columbia	2516	Pub	R1	PSYCH	26	26.00	478	478	-0.46	PSYC06	0.897	341.00
Florida State University	1489	Pub	R2	PSYCH	29	29.00	1,594	1,594	-0.41	PSYC06	0.897	341.00
University of Utah	3675	Pub	R1	PSYCH	29	29.00	180	180	-0.32	PSYC06	0.897	341.00
SUNY at Stony Brook, All Campuses	2838	Pub	R1	PSYCH	41	41.00	734	734	-0.27	PSYC06	0.897	341.00
Pennsylvania State U, Main Campus	6965	Pub	R1	PSYCH	32	32.00	236	236	-0.26	PSYC06	0.897	341.00
SUNY at Albany	2835	Pub	R2	PSYCH	22	22.00	459	459	-0.23	PSYC06	0.897	341.00
Wayne State University	2329	Pub	R2	PSYCH	40	40.00	246	246	-0.22	PSYC06	0.897	341.00
University of Colorado at Boulder	1370	Pub	R1	PSYCH	45	45.00	3,599	3,599	-0.21	PSYC06	0.897	341.00
Washington State University	3800	Pub	R2	PSYCH	21	21.00	37	37	-0.20	PSYC06	0.897	341.00
University of South Carolina at Columbia	3448	Pub	R2	PSYCH	33	33.00	265	265	-0.20	PSYC07	0.874	501.00
Michigan State University	2290	Pub	R1	PSYCH	55	55.00	1,891	1,891	-0.18	PSYC07	0.874	501.00
University of Illinois at Urbana-Champaign	1775	Pub	R1	PSYCH	56	56.00	2,039	2,039	-0.15	PSYC07	0.874	501.00
University of California-Los Angeles	1315	Pub	R1	PSYCH	68	68.00	2,934	2,934	-0.15	PSYC07	0.874	501.00
Georgia State University	1574	Pub	D1	PSYCH	29	29.00	158	158	-0.14	PSYC07	0.874	501.00
University of Vermont	3696	Pub	D2	PSYCH	15	15.00	147	147	-0.12	PSYC07	0.874	501.00
University of Connecticut, Main Campus	29013	Pub	R1	PSYCH	44	44.00	3,761	3,761	-0.11	PSYC07	0.874	501.00
Southern Illinois University-Carbondale	1758	Pub	R2	PSYCH	37	37.00	164	164	-0.10	PSYC07	0.874	501.00
Indiana University at Bloomington	1809	Pub	R1	PSYCH	40	40.00	1,311	1,311	-0.09	PSYC07	0.874	501.00
Texas Tech University	3644	Pub	D1	PSYCH	19	19.00	224	224	-0.09	PSYC07	0.874	501.00
University of North Carolina at Chapel Hill	2974	Pub	R1	PSYCH	40	40.00	287	287	-0.09	PSYC07	0.874	501.00
University of Hawaii at Manoa	1610	Pub	R1	PSYCH	25	25.00	93	93	-0.08	PSYC07	0.874	501.00
SUNY at Buffalo, Main Campus	2837	Pub	R2	PSYCH	40	40.00	221	221	-0.06	PSYC07	0.874	501.00
University of Arizona	1083	Pub	R1	PSYCH	29	29.00	157	157	-0.04	PSYC08	0.753	426.95
Memphis State University	3509	Pub	D1	PSYCH	0	22.34	2	2	-0.04	PSYC08	0.753	426.95
University of California-Berkeley	1312	Pub	R1	PSYCH	40	40.00	2,708	2,708	-0.04	PSYC08	0.753	426.95
Arizona State University	1081	Pub	R2	PSYCH	21	21.00	262	262	-0.01	PSYC08	0.753	426.95
University of North Dakota, All Campuses	3005	Pub	D2	PSYCH	15	15.00	0	17	0.01	PSYC08	0.753	426.95
University of Oklahoma, Norman Campus	3184	Pub	R2	PSYCH	14	14.00	569	569	0.01	PSYC08	0.753	426.95
Oklahoma State University, All Campuses	3170	Pub	R2	PSYCH	23	23.00	17	17	0.01	PSYC08	0.753	426.95
University of Maryland at College Park	2103	Pub	R1	PSYCH	41	41.00	824	824	0.04	PSYC08	0.753	426.95
Virginia Commonwealth University	3735	Pub	R2	PSYCH	29	29.00	21	21	0.05	PSYC08	0.753	426.95
Ohio University, All Campuses	3100	Pub	D1	PSYCH	26	26.00	127	127	0.06	PSYC08	0.753	426.95
North Carolina State University at Raleigh	2972	Pub	R1	PSYCH	19	19.00	30	30	0.10	PSYC08	0.753	426.95
Texas A & M University, Main Campus	10366	Pub	R1	PSYCH	0	27.61	11	11	0.10	PSYC08	0.753	426.95
University of Pittsburgh Main Campus	3379	Pub	R1	PSYCH	44	44.00	427	427	0.11	PSYC08	0.753	426.95
University of South Dakota	3474	Pub	D2	PSYCH	12	12.00	136	136	0.11	PSYC08	0.753	426.95
University of Oregon	3223	Pub	R2	PSYCH	34	34.00	940	940	0.11	PSYC08	0.753	426.95
Kent State University, All Campuses	3051	Pub	D1	PSYCH	30	30.00	201	201	0.12	PSYC08	0.753	426.95
University of Houston-University Park	3652	Pub	D1	PSYCH	52	52.00	1,090	1,090	0.13	PSYC09	0.634	684.65
University of California-Davis	1313	Pub	R1	PSYCH	22	22.00	175	175	0.14	PSYC09	0.634	684.65
University of Michigan at Ann Arbor	9092	Pub	R1	PSYCH	111	111.00	4,045	4,045	0.15	PSYC09	0.634	684.65

Table 5-A.7: Segmentation Array: Psychology

School	FICE	TOC	Carnegie Class	Academic Discipline	Faculty	Faculty (adjusted)	R&D Expenditures	R&D Exp (adjusted)	Factor Score	Segment	Segment RU Fraction	Segment Faculty
University of Florida	1535	Pub	R1	PSYCH	41	41.00	938	938	0.15	PSYC09	0.634	684.65
University of Montana	2536	Pub	D1	PSYCH	16	16.00	40	40	0.16	PSYC09	0.634	684.65
University of Rhode Island	3414	Pub	R2	PSYCH	21	21.00	0	18	0.17	PSYC09	0.634	684.65
Indiana State University, Terre Haute	9563	Pub	D2	PSYCH	0	11.88	0	12	0.18	PSYC09	0.634	684.65
University of Wyoming	3932	Pub	R2	PSYCH	14	14.00	71	71	0.19	PSYC09	0.634	684.65
University of Nevada-Reno	2568	Pub	D2	PSYCH	0	11.15	204	204	0.21	PSYC09	0.634	684.65
University of North Carolina at Greensboro	2976	Pub	D2	PSYCH	19	19.00	115	115	0.21	PSYC09	0.634	684.65
Purdue University, Main Campus	1825	Pub	R1	PSYCH	63	63.00	564	564	0.21	PSYC09	0.634	684.65
University of New Mexico, All Campuses	10313	Pub	R1	PSYCH	25	25.00	131	131	0.21	PSYC09	0.634	684.65
University of Toledo	3131	Pub	D1	PSYCH	17	17.00	0	19	0.22	PSYC09	0.634	684.65
University of Alabama	1051	Pub	D1	PSYCH	23	23.00	13	13	0.22	PSYC09	0.634	684.65
West Virginia University	3827	Pub	R2	PSYCH	26	26.00	36	36	0.23	PSYC09	0.634	684.65
University of Kansas, Main Campus	1948	Pub	R2	PSYCH	86	86.00	5,008	5,008	0.24	PSYC09	0.634	684.65
University of California-Santa Barbara	1320	Pub	R2	PSYCH	25	25.00	643	643	0.25	PSYC09	0.634	684.65
SUNY at Binghamton	2836	Pub	D1	PSYCH	19	19.00	485	485	0.26	PSYC09	0.634	684.65
University of Louisville	1999	Pub	D1	PSYCH	22	22.00	168	168	0.27	PSYC09	0.634	684.65
University of South Florida	1537	Pub	D1	PSYCH	32	32.00	113	113	0.28	PSYC09	0.634	684.65
Ball State University	1786	Pub	D1	PSYCH	0	27.61	10	10	0.28	PSYC09	0.634	684.65
University of Massachusetts at Amherst	2221	Pub	R2	PSYCH	54	54.00	757	757	0.28	PSYC10	0.473	1396.66
Iowa State University	1869	Pub	R2	PSYCH	31	31.00	343	343	0.30	PSYC10	0.473	1396.66
University of Missouri, Kansas City	2518	Pub	D2	PSYCH	0	16.64	11	11	0.30	PSYC10	0.473	1396.66
University of Akron, All Campuses	3123	Pub	D1	PSYCH	0	14.00	88	88	0.30	PSYC10	0.473	1396.66
Miami University, All Campuses	7104	Pub	D1	PSYCH	23	23.00	84	84	0.33	PSYC10	0.473	1396.66
Utah State University	3677	Pub	R2	PSYCH	20	20.00	137	137	0.35	PSYC10	0.473	1396.66
Kansas State University of Agriculture and App	1928	Pub	R2	PSYCH	17	17.00	36	36	0.37	PSYC10	0.473	1396.66
University of California-Riverside	1316	Pub	D1	PSYCH	14	14.00	213	213	0.38	PSYC10	0.473	1396.66
University of Missouri, Saint Louis	2519	Pub	D2	PSYCH	0	18.76	68	68	0.38	PSYC10	0.473	1396.66
University of Texas at Dallas	9741	Pub	D2	PSYCH	0	11.03	110	110	0.38	PSYC10	0.473	1396.66
Middle Tennesse State University	3510	Pub	D2	PSYCH	0	22.82	0	23	0.38	PSYC10	0.473	1396.66
University of Iowa	1892	Pub	R1	PSYCH	32	32.00	768	768	0.39	PSYC10	0.473	1396.66
University of Arkansas, Main Campus	1108	Pub	D1	PSYCH	20	20.00	0	15	0.40	PSYC10	0.473	1396.66
Cleveland State University	3032	Pub	D2	PSYCH	0	14.66	11	11	0.41	PSYC10	0.473	1396.66
University of California-San Diego	1,317	Pub	R1	PSYCH	22	22.00	715	715	0.42	PSYC10	0.473	1396.66
University of Illinois at Chicago	1776	Pub	R1	PSYCH	35	35.00	199	199	0.43	PSYC10	0.473	1396.66
University of Delaware	1431	Pub	R2	PSYCH	20	20.00	194	194	0.43	PSYC10	0.473	1396.66
University of Virginia, Main Campus	6968	Pub	R1	PSYCH	35	35.00	499	499	0.45	PSYC10	0.473	1396.66
Bowling Green State University, All Campuses	3018	Pub	D1	PSYCH	31	31.00	538	538	0.46	PSYC10	0.473	1396.66
University of New Hampshire, Main Campus	2589	Pub	D2	PSYCH	16	16.00	59	59	0.46	PSYC10	0.473	1396.66
University of Cincinnati, All Campuses	3125	Pub	R1	PSYCH	39	39.00	11	11	0.46	PSYC10	0.473	1396.66
Colorado State University	1350	Pub	R1	PSYCH	29	29.00	339	339	0.47	PSYC10	0.473	1396.66
University of Washington	3798	Pub	R1	PSYCH	61	61.00	1,462	1,462	0.49	PSYC10	0.473	1396.66
Northern Arizona University	1082	Pub	D2	PSYCH	0	18.93	16	16	0.53	PSYC10	0.473	1396.66
Mississippi State University	2423	Pub	R2	PSYCH	0	13.35	0	13	0.53	PSYC10	0.473	1396.66
Illinois State University	1692	Pub	D2	PSYCH	0	36.09	20	20	0.55	PSYC10	0.473	1396.66

Table 5-A.7: Segmentation Array: Psychology

School	FICE	TOC	Carnegie Class	Academic Discipline	Faculty	Faculty (adjusted)	R&D Expenditures	R&D Exp (adjusted)	Factor Score	Segment	Segment RU Fraction	Segment Faculty
Old Dominion University	3728	Pub	D2	PSYCH	0	25.47	152	152	0.57	PSYC10	0.473	1396.66
Rutgers, the State University at New Brunswick	6964	Pub	R1	PSYCH	99	99.00	2,365	2,365	0.58	PSYC10	0.473	1396.66
Auburn University, Main Campus	1009	Pub	R2	PSYCH	33	33.00	0	23	0.58	PSYC10	0.473	1396.66
University of Texas at Arlington	3656	Pub	D2	PSYCH	0	15.81	17	17	0.60	PSYC10	0.473	1396.66
University of California-Santa Cruz	1321	Pub	D1	PSYCH	0	16.81	258	258	0.61	PSYC10	0.473	1396.66
Portland State University	3216	Pub	D2	PSYCH	0	16.53	19	19	0.61	PSYC10	0.473	1396.66
Northern Illinois University	1737	Pub	D1	PSYCH	27	27.00	146	146	0.61	PSYC10	0.473	1396.66
Georgia Institute of Technology, Main Campus	1569	Pub	R1	PSYCH	0	14.69	134	134	0.63	PSYC10	0.473	1396.66
University of Maine at Orono	2053	Pub	D2	PSYCH	0	16.64	65	65	0.65	PSYC10	0.473	1396.66
Virginia Polytechnic Institute and State Univ	3754	Pub	R1	PSYCH	27	27.00	198	198	0.66	PSYC10	0.473	1396.66
University of New Orleans	2015	Pub	D2	PSYCH	0	14.66	63	63	0.68	PSYC10	0.473	1396.66
University of Idaho	1626	Pub	D2	PSYCH	0	12.15	0	12	0.68	PSYC10	0.473	1396.66
University of Maryland Baltimore County	2105	Pub	D2	PSYCH	0	19.32	47	47	0.71	PSYC10	0.473	1396.66
Florida Atlantic University	1481	Pub	D2	PSYCH	0	7.25	34	34	0.78	PSYC10	0.473	1396.66
North Dakota State University, All Campuses	9265	Pub	D2	PSYCH	0	7.23	165	165	0.80	PSYC10	0.473	1396.66
CUNY Graduate School and University Center	4063	Pub	D1	PSYCH	158	158.00	488	488	0.84	PSYC10	0.473	1396.66
New Mexico State University, All Campuses	2657	Pub	R1	PSYCH	0	36.95	178	178	0.85	PSYC10	0.473	1396.66
College of William and Mary	3705	Pub	D1	PSYCH	0	16.07	4	4	0.85	PSYC10	0.473	1396.66
University of California-Irvine	1314	Pub	R1	PSYCH	30	30.00	7	7	0.87	PSYC10	0.473	1396.66
University of Alabama at Birmingham	1052	Pub	D2	PSYCH	0	27.46	0	27	0.90	PSYC10	0.473	1396.66
Tennessee Technological University	3523	Pub	D2	PSYCH	0	23.70	63	63	0.90	PSYC10	0.473	1396.66
Oregon State University	3210	Pub	R1	PSYCH	0	11.79	0	12	0.92	PSYC10	0.473	1396.66
University of Northern Colorado	1349	Pub	D1	PSYCH	0	23.87	0	24	0.92	PSYC10	0.473	1396.66
Montana State University	2532	Pub	D2	PSYCH	0	16.88	0	17	0.92	PSYC10	0.473	1396.66
Idaho State University	1620	Pub	D2	PSYCH	0	7.25	2	2	0.93	PSYC10	0.473	1396.66
Clemson University	3425	Pub	D1	PSYCH	0	13.31	0	13	0.98	PSYC10	0.473	1396.66
Louisiana Tech University	2008	Pub	D2	PSYCH	0	4.69	12	12	1.03	PSYC10	0.473	1396.66
University of Missouri, Rolla	2517	Pub	D2	PSYCH	0	8.86	1	1	1.04	PSYC10	0.473	1396.66
Colorado School of Mines	1348	Pub	D2	PSYCH	0 •		0 •		•	PSYC10	0.473	1396.66
East Texas State University, All Campuses	3565	Pub	D2	PSYCH	0 •		1	1	•	PSYC10	0.473	1396.66
Louisiana State University and Agric & Mech Co	2010	Pub	R1	PSYCH	0 •		0 •		•	PSYC10	0.473	1396.66
SUNY College of Environmental Science and F	2851	Pub	D2	PSYCH	0 •		0 •		•	PSYC10	0.473	1396.66
University of California-San Francisco	1319	Pub	R1	PSYCH	0 •		0 •		•	PSYC10	0.473	1396.66

Table 5-A.8: Segmentation Array: Chemical Engineering

School	FICE	TOC	Carnegie Class	Academic Discipline	Faculty	Faculty (adjusted)	R&D Expenditures	R&D Exp (adjusted)	Factor Score	Segment	Segment RU Fraction	Segment Faculty
Stanford University	1305	Pri	R1	ChemEng	9	9.00	1,804	1,804	-3.89	CENG01	0.711	90.00
University of Southern California	1328	Pri	R1	ChemEng	8	8.00	330	330	-1.92	CENG01	0.711	90.00
Illinois Institute of Technology	1691	Pri	D1	ChemEng	6	6.00	348	348	-1.74	CENG01	0.711	90.00
Polytechnic University	2796	Pri	D2	ChemEng	6	6.00	418	418	-1.58	CENG01	0.711	90.00
University of Tulsa	3185	Pri	D2	ChemEng	8	8.00	0	13	-1.48	CENG01	0.711	90.00
Columbia University, Main Campus	2707	Pri	R1	ChemEng	10	10.00	557	557	-1.46	CENG01	0.711	90.00
California Institute of Technology	1131	Pri	R1	ChemEng	11	11.00	694	694	-1.41	CENG01	0.711	90.00
University of Notre Dame	1840	Pri	D1	ChemEng	6	6.00	257	257	-1.13	CENG01	0.711	90.00
University of Pennsylvania	3378	Pri	R1	ChemEng	11	11.00	725	725	-0.84	CENG01	0.711	90.00
Princeton University	2627	Pri	R1	ChemEng	15	15.00	872	872	-0.84	CENG01	0.711	90.00
Carnegie Mellon University	3242	Pri	R1	ChemEng	15	15.00	1,076	1,076	-0.82	CENG02	0.669	324.48
Case Western Reserve University	3024	Pri	R1	ChemEng	11	11.00	762	762	-0.48	CENG02	0.669	324.48
Washington University	2520	Pri	R1	ChemEng	9	9.00	98	98	-0.28	CENG02	0.669	324.48
Northwestern University	1739	Pri	R1	ChemEng	20	20.00	395	395	-0.05	CENG02	0.669	324.48
Cornell University, All Campuses	2711	Pri	R1	ChemEng	15	15.00	337	337	0.00	CENG02	0.669	324.48
Rice University	3604	Pri	D1	ChemEng	13	13.00	459	459	0.00	CENG02	0.669	324.48
Lehigh University	3289	Pri	D1	ChemEng	14	14.00	223	223	0.01	CENG02	0.669	324.48
Massachusetts Institute of Technology	2178	Pri	R1	ChemEng	53	53.00	5,036	5,036	0.03	CENG02	0.669	324.48
Stevens Institute of Technology	2639	Pri	D2	ChemEng	9	9.00	0	7	0.05	CENG02	0.669	324.48
Clarkson University	2699	Pri	D2	ChemEng	17	17.00	473	473	0.05	CENG02	0.669	324.48
University of Rochester	2894	Pri	R1	ChemEng	10	10.00	292	292	0.27	CENG02	0.669	324.48
Tufts University	2219	Pri	D1	ChemEng	0	5.51	49	49	0.28	CENG02	0.669	324.48
Syracuse University, Main Campus	2882	Pri	R2	ChemEng	12	12.00	325	325	0.30	CENG02	0.669	324.48
Drexel University	3256	Pri	D2	ChemEng	0	5.90	142	142	0.34	CENG02	0.669	324.48
Tulane University of Louisiana	2029	Pri	R2	ChemEng	7	7.00	47	47	0.47	CENG02	0.669	324.48
Northeastern University	2199	Pri	D2	ChemEng	0	5.90	58	58	0.49	CENG02	0.669	324.48
Brigham Young University, Main Campus	3670	Pri	D1	ChemEn	14	14.00	102	102	0.52	CENG02	0.669	324.48
Rensselaer Polytechnic Institute	2803	Pri	R2	ChemEn	20	20.00	847	847	0.57	CENG02	0.669	324.48
Vanderbilt University	3535	Pri	R1	ChemEng	9	9.00	45	45	0.68	CENG02	0.669	324.48
Harvard University	2155	Pri	R1	ChemEng	0	1.89	209	209	0.78	CENG02	0.669	324.48
Yale University	1426	Pri	R1	ChemEng	10	10.00	195	195	0.84	CENG02	0.669	324.48
George Washington University	1444	Pri	R2	ChemEng	0	0.97	251	251	0.90	CENG02	0.669	324.48
University of Denver	1371	Pri	D1	ChemEng	0	4.30	591	591	1.02	CENG02	0.669	324.48
Catholic University of America	1437	Pri	D1	ChemEng	9	9.00	0	9	1.04	CENG02	0.669	324.48
Howard University	1448	Pri	R1	ChemEng	0	5.23	24	24	1.09	CENG02	0.669	324.48
Johns Hopkins University	2077	Pri	R1	ChemEng	0	7.30	145	145	1.18	CENG02	0.669	324.48
Dartmouth College	2573	Pri	D2	ChemEng	0	3.47	84	84	1.22	CENG02	0.669	324.48
Emory University	1564	Pri	R2	ChemEng	0	7.98	0	8	1.25	CENG02	0.669	324.48
Loma Linda University	1218	Pri	D2	ChemEng	0	4.30	0	4	1.26	CENG02	0.669	324.48
Brandeis University	2133	Pri	R2	ChemEng	0	2.77	0	3	1.26	CENG02	0.669	324.48
Florida Institute of Technology	1469	Pri	D2	ChemEng	0	0.97	0	1	1.27	CENG02	0.669	324.48
Hofstra University	2732	Pri	D2	ChemEng	0	0.97	0	1	1.27	CENG02	0.669	324.48
Adelphi University	2666	Pri	D2	ChemEng	0	0.00	0 •		•	CENG02	0.669	324.48
American University	1434	Pri	D1	ChemEng	0	0.00	0 •		•	CENG02	0.669	324.48

Table 5-A.8: Segmentation Array: Chemical Engineering

School	FICE	TOC	Carnegie Class	Academic Discipline	Faculty	Faculty (adjusted)	R&D Expenditures	R&D Exp (adjusted)	Factor Score	Segment	Segment RU Fraction	Segment Faculty
Andrews University	2238	Pri	D2	ChemEng	0	0.00	0	•		• CENG02	0.669	324.48
Baylor University	6967	Pri	D2	ChemEng	0	0.00	0	•		• CENG02	0.669	324.48
Biola University	1122	Pri	D2	ChemEng	0	0.00	0	•		• CENG02	0.669	324.48
Boston College	2128	Pri	D1	ChemEng	0	0.00	0	•		• CENG02	0.669	324.48
Boston University	2130	Pri	R1	ChemEng	0	0.00	2	2		• CENG02	0.669	324.48
Brown University	3401	Pri	R2	ChemEng	0	0.00	288	288		• CENG02	0.669	324.48
Claremont Univ Center & Graduate School	1169	Pri	D1	ChemEng	0	0.00	0	•		• CENG02	0.669	324.48
Clark Atlanta University	1559	Pri	D2	ChemEng	0	0.00	0	•		• CENG02	0.669	324.48
Clark University	2139	Pri	D2	ChemEng	0	0.00	0	•		• CENG02	0.669	324.48
Columbia University, Teachers College	3979	Pri	D1	ChemEng	0	0.00	0	•		• CENG02	0.669	324.48
Drake University	1860	Pri	D2	ChemEng	0	0.00	0	•		• CENG02	0.669	324.48
Duke University	2920	Pri	R1	ChemEng	0	0.00	0	•		• CENG02	0.669	324.48
Duquesne University	3258	Pri	D2	ChemEng	0	0.00	0	•		• CENG02	0.669	324.48
Fordham University	2722	Pri	D1	ChemEng	0	0.00	0	•		• CENG02	0.669	324.48
Georgetown University	1445	Pri	R2	ChemEng	0	0.00	0	•		• CENG02	0.669	324.48
Hahnemann University	3271	Pri	D2	ChemEng	0	0.00	0	•		• CENG02	0.669	324.48
Loyola University of Chicago	1710	Pri	D1	ChemEng	0	0.00	0	•		• CENG02	0.669	324.48
Marquette University	3863	Pri	D1	ChemEng	0	0.00	22	22		• CENG02	0.669	324.48
New School For Social Research	2780	Pri	D2	ChemEng	0	0.00	0	•		• CENG02	0.669	324.48
New York University	2785	Pri	R1	ChemEng	0	0.00	0	•		• CENG02	0.669	324.48
Nova University	1509	Pri	D1	ChemEng	0	0.00	0	•		• CENG02	0.669	324.48
Pepperdine University	1264	Pri	D2	ChemEng	0	0.00	0	•		• CENG02	0.669	324.48
Rockefeller University	2807	Pri	R1	ChemEng	0	0.00	0	•		• CENG02	0.669	324.48
Saint John's University New York	2823	Pri	D1	ChemEng	0	0.00	0	•		• CENG02	0.669	324.48
Saint Louis University, Main Campus	2506	Pri	D1	ChemEng	0	0.00	3	3		• CENG02	0.669	324.48
Southern Methodist University	3613	Pri	D2	ChemEng	0	0.00	57	57		• CENG02	0.669	324.48
Texas Christian University	3636	Pri	D2	ChemEng	0	0.00	0	•		• CENG02	0.669	324.48
Union Institute	10923	Pri	D1	ChemEng	0	0.00	0	•		• CENG02	0.669	324.48
University of Chicago	1774	Pri	R1	ChemEng	0	0.00	0	•		• CENG02	0.669	324.48
University of Miami	1536	Pri	R1	ChemEng	0	0.00	0	•		• CENG02	0.669	324.48
University of San Francisco	1325	Pri	D2	ChemEng	0	0.00	0	•		• CENG02	0.669	324.48
Yeshiva University	2903	Pri	R1	ChemEng	0	0.00	0	•		• CENG02	0.669	324.48
Colorado School of Mines	1348	Pub	D2	ChemEng	0	8.39	293	293	-2.80	CENG03	0.737	77.39
Auburn University, Main Campus	1009	Pub	R2	ChemEng	5	5.00	1,036	1,036	-2.35	CENG03	0.737	77.39
University of Texas at Austin	3658	Pub	R1	ChemEng	17	17.00	2,044	2,044	-2.26	CENG03	0.737	77.39
Pennsylvania State U, Main Campus	6965	Pub	R1	ChemEng	13	13.00	816	816	-2.19	CENG03	0.737	77.39
North Carolina State University at Raleigh	2972	Pub	R1	ChemEng	10	10.00	642	642	-1.61	CENG03	0.737	77.39
University of Houston-University Park	3652	Pub	D1	ChemEng	12	12.00	1,437	1,437	-1.61	CENG03	0.737	77.39
University of Oklahoma, Norman Campus	3184	Pub	R2	ChemEng	12	12.00	197	197	-1.58	CENG03	0.737	77.39
University of Delaware	1,431	Pub	R2	ChemEng	17	17.00	2,380	2,380	-1.53	CENG04	1.000	76.61
Purdue University, Main Campus	1825	Pub	R1	ChemEng	21	21.00	1,417	1,417	-1.53	CENG04	1.000	76.61
Texas A & M University, Main Campus	10366	Pub	R1	ChemEng	14	14.00	374	374	-1.51	CENG04	1.000	76.61
University of Iowa	1892	Pub	R1	ChemEng	0	3.61	230	230	-1.45	CENG04	1.000	76.61
University of Illinois at Urbana-Champaign	1775	Pub	R1	ChemEng	11	11.00	424	424	-1.18	CENG04	1.000	76.61

Table 5-A.8: Segmentation Array: Chemical Engineering

School	FICE	TOC	Carnegie Class	Academic Discipline	Faculty	Faculty (adjusted)	R&D Expenditures	R&D Exp (adjusted)	Factor Score	Segment	Segment RU Fraction	Segment Faculty
University of Utah	3675	Pub	R1	ChemEng	10	10.00	615	615	-1.14	CENG04	1.000	76.61
University of California-Berkeley	1312	Pub	R1	ChemEng	23	23.00	0	17	-1.08	CENG05	1.000	118.00
University of Minnesota at Twin Cities	3969	Pub	R1	ChemEng	20	20.00	1,434	1,434	-0.88	CENG05	1.000	118.00
Rutgers, the State University at New Brunswick	6964	Pub	R1	ChemEng	7	7.00	173	173	-0.69	CENG05	1.000	118.00
University of Pittsburgh Main Campus	3379	Pub	R1	ChemEng	12	12.00	282	282	-0.48	CENG05	1.000	118.00
SUNY at Buffalo, Main Campus	2837	Pub	R2	ChemEng	13	13.00	179	179	-0.43	CENG05	1.000	118.00
University of Wisconsin-Madison	3895	Pub	R1	ChemEng	17	17.00	1,292	1,292	-0.42	CENG05	1.000	118.00
Iowa State University	1869	Pub	R2	ChemEng	16	16.00	488	488	-0.36	CENG05	1.000	118.00
West Virginia University	3827	Pub	R2	ChemEng	10	10.00	109	109	-0.32	CENG05	1.000	118.00
Oklahoma State University, All Campuses	3170	Pub	R2	ChemEng	9	9.00	437	437	-0.30	CENG06	0.701	544.44
Louisiana Tech University	2008	Pub	D2	ChemEng	0	4.30	39	39	-0.22	CENG06	0.701	544.44
University of Michigan at Ann Arbor	9092	Pub	R1	ChemEng	19	19.00	947	947	-0.13	CENG06	0.701	544.44
University of Washington	3798	Pub	R1	ChemEng	18	18.00	492	492	-0.10	CENG06	0.701	544.44
Michigan State University	2290	Pub	R1	ChemEng	9	9.00	484	484	-0.09	CENG06	0.701	544.44
University of Maryland at College Park	2103	Pub	R1	ChemEng	12	12.00	303	303	-0.05	CENG06	0.701	544.44
University of Missouri, Rolla	2517	Pub	D2	ChemEng	15	15.00	542	542	-0.03	CENG06	0.701	544.44
University of California-Davis	1313	Pub	R1	ChemEng	0	7.13	396	396	-0.03	CENG06	0.701	544.44
University of Kentucky, Main Campus	1989	Pub	R1	ChemEng	10	10.00	425	425	-0.02	CENG06	0.701	544.44
Georgia Institute of Technology, Main Campus	1569	Pub	R1	ChemEng	19	19.00	2,367	2,367	0.04	CENG06	0.701	544.44
University of Idaho	1626	Pub	D2	ChemEng	5	5.00	12	12	0.04	CENG06	0.701	544.44
University of Arizona	1083	Pub	R1	ChemEng	0	7.30	604	604	0.06	CENG06	0.701	544.44
University of Cincinnati, All Campuses	3125	Pub	R1	ChemEng	10	10.00	185	185	0.07	CENG06	0.701	544.44
Ohio State University, Main Campus	6883	Pub	R1	ChemEng	13	13.00	274	274	0.11	CENG06	0.701	544.44
University of Louisville	1999	Pub	D1	ChemEng	0	7.01	38	38	0.13	CENG06	0.701	544.44
Oregon State University	3210	Pub	R1	ChemEng	7	7.00	1,017	1,017	0.17	CENG06	0.701	544.44
Mississippi State University	2423	Pub	R2	ChemEng	0	5.90	60	60	0.22	CENG06	0.701	544.44
Virginia Polytechnic Institute and State Univ	3754	Pub	R1	ChemEng	0	10.33	476	476	0.23	CENG06	0.701	544.44
Texas Tech University	3644	Pub	D1	ChemEng	0	9.87	423	423	0.24	CENG06	0.701	544.44
University of Virginia, Main Campus	6968	Pub	R1	ChemEng	10	10.00	149	149	0.33	CENG06	0.701	544.44
Montana State University	2532	Pub	D2	ChemEng	5	5.00	103	103	0.33	CENG06	0.701	544.44
Cleveland State University	3032	Pub	D2	ChemEng	0	9.04	93	93	0.34	CENG06	0.701	544.44
University of Alabama	1051	Pub	D1	ChemEng	0	6.60	77	77	0.34	CENG06	0.701	544.44
University of Kansas, Main Campus	1948	Pub	R2	ChemEng	13	13.00	154	154	0.36	CENG06	0.701	544.44
University of Arkansas, Main Campus	1108	Pub	D1	ChemEng	0	7.28	367	367	0.38	CENG06	0.701	544.44
University of South Carolina at Columbia	3448	Pub	R2	ChemEng	0	5.17	47	47	0.39	CENG06	0.701	544.44
University of California-Los Angeles	1315	Pub	R1	ChemEng	10	10.00	1,355	1,355	0.40	CENG06	0.701	544.44
University of Massachusetts at Amherst	2221	Pub	R2	ChemEng	14	14.00	264	264	0.41	CENG06	0.701	544.44
New Mexico State University, All Campuses	2657	Pub	R1	ChemEng	0	9.04	1,590	1,590	0.45	CENG06	0.701	544.44
Tennessee Technological University	3523	Pub	D2	ChemEng	0	4.30	83	83	0.48	CENG06	0.701	544.44
Arizona State University	1081	Pub	R2	ChemEng	0	6.60	23	23	0.48	CENG06	0.701	544.44
University of Tennessee at Knoxville	3530	Pub	R1	ChemEng	25	25.00	0	22	0.49	CENG06	0.701	544.44
University of New Mexico, All Campuses	10313	Pub	R1	ChemEng	0	12.42	591	591	0.51	CENG06	0.701	544.44
University of Akron, All Campuses	3123	Pub	D1	ChemEng	6	6.00	24	24	0.54	CENG06	0.701	544.44
University of Toledo	3131	Pub	D1	ChemEng	0	7.71	40	40	0.55	CENG06	0.701	544.44

Table 5-A.8: Segmentation Array: Chemical Engineering

School	FICE	TOC	Carnegie Class	Academic Discipline	Faculty	Faculty (adjusted)	R&D Expenditures	R&D Exp (adjusted)	Factor Score	Segment	Segment RU Fraction	Segment Faculty
University of Connecticut, Main Campus	29013	Pub	R1	ChemEng	12	12.00	628	628	0.55	CENG06	0.701	544.44
University of Wyoming	3932	Pub	R2	ChemEng	0	9.17	68	68	0.56	CENG06	0.701	544.44
Ohio University, All Campuses	3100	Pub	D1	ChemEng	0	7.01	448	448	0.59	CENG06	0.701	544.44
University of Florida	1535	Pub	R1	ChemEng	13	13.00	1,187	1,187	0.63	CENG06	0.701	544.44
Washington State University	3800	Pub	R2	ChemEng	0	8.90	265	265	0.68	CENG06	0.701	544.44
University of Colorado at Boulder	1370	Pub	R1	ChemEng	12	12.00	235	235	0.68	CENG06	0.701	544.44
SUNY College of Environmental Science and F	2851	Pub	D2	ChemEng	9	9.00	1,415	1,415	0.69	CENG06	0.701	544.44
University of Nebraska at Lincoln	2565	Pub	R2	ChemEng	0	4.41	21	21	0.71	CENG06	0.701	544.44
University of Missouri, Columbia	2516	Pub	R1	ChemEng	10	10.00	33	33	0.71	CENG06	0.701	544.44
Clemson University	3425	Pub	D1	ChemEng	11	11.00	237	237	0.72	CENG06	0.701	544.44
University of California-Santa Barbara	1320	Pub	R2	ChemEng	0	10.97	317	317	0.74	CENG06	0.701	544.44
Kansas State University of Agriculture and App	1928	Pub	R2	ChemEng	9	9.00	296	296	0.79	CENG06	0.701	544.44
University of Maine at Orono	2053	Pub	D2	ChemEng	0	9.17	699	699	0.79	CENG06	0.701	544.44
University of Rhode Island	3414	Pub	R2	ChemEng	8	8.00	210	210	0.89	CENG06	0.701	544.44
University of North Dakota, All Campuses	3005	Pub	D2	ChemEng	0	8.56	120	120	0.90	CENG06	0.701	544.44
Wayne State University	2329	Pub	R2	ChemEng	17	17.00	143	143	0.92	CENG06	0.701	544.44
University of New Hampshire, Main Campus	2589	Pub	D2	ChemEng	0	9.96	43	43	0.93	CENG06	0.701	544.44
University of Mississippi, Main Campus	2440	Pub	D1	ChemEng	0	5.90	62	62	1.01	CENG06	0.701	544.44
Western Michigan University	2330	Pub	D1	ChemEng	0	1.89	2	2	1.20	CENG06	0.701	544.44
Southern Illinois University-Carbondale	1758	Pub	R2	ChemEng	0	5.17	13	13	1.25	CENG06	0.701	544.44
University of South Florida	1537	Pub	D1	ChemEng	0	4.41	4	4	1.26	CENG06	0.701	544.44
Kent State University, All Campuses	3051	Pub	D1	ChemEng	0	0.97	0	1	1.27	CENG06	0.701	544.44
Northern Illinois University	1737	Pub	D1	ChemEng	0	0.97	0	1	1.27	CENG06	0.701	544.44
Ball State University	1786	Pub	D1	ChemEng	0	0.00	0 •		•	CENG06	0.701	544.44
Bowling Green State University, All Campuses	3018	Pub	D1	ChemEng	0	0.00	0 •		•	CENG06	0.701	544.44
College of William and Mary	3705	Pub	D1	ChemEng	0	0.00	0 •		•	CENG06	0.701	544.44
Colorado State University	1350	Pub	R1	ChemEng	0	0.00	798	798	•	CENG06	0.701	544.44
CUNY Graduate School and University Center	4063	Pub	D1	ChemEng	7	7.00	0 •		•	CENG06	0.701	544.44
East Texas State University, All Campuses	3565	Pub	D2	ChemEng	0	0.00	0 •		•	CENG06	0.701	544.44
Florida Atlantic University	1481	Pub	D2	ChemEng	0	0.00	0 •		•	CENG06	0.701	544.44
Florida State University	1489	Pub	R2	ChemEng	0	0.00	0 •		•	CENG06	0.701	544.44
Georgia State University	1574	Pub	D1	ChemEng	0	0.00	0 •		•	CENG06	0.701	544.44
Idaho State University	1620	Pub	D2	ChemEng	0	0.00	10	10	•	CENG06	0.701	544.44
Illinois State University	1692	Pub	D2	ChemEng	0	0.00	0 •		•	CENG06	0.701	544.44
Indiana State University, Terre Haute	9563	Pub	D2	ChemEng	0	0.00	0 •		•	CENG06	0.701	544.44
Indiana University at Bloomington	1809	Pub	R1	ChemEng	0	0.00	0 •		•	CENG06	0.701	544.44
Louisiana State University and Agric & Mech C	2010	Pub	R1	ChemEng	0	0.00	0 •		•	CENG06	0.701	544.44
Memphis State University	3509	Pub	D1	ChemEng	0	0.00	30	30	•	CENG06	0.701	544.44
Miami University, All Campuses	7104	Pub	D1	ChemEng	0	0.00	3	3	•	CENG06	0.701	544.44
Middle Tennesse State University	3510	Pub	D2	ChemEng	0	0.00	0 •		•	CENG06	0.701	544.44
North Dakota State University, All Campuses	9265	Pub	D2	ChemEng	0	0.00	0 •		•	CENG06	0.701	544.44
Northern Arizona University	1082	Pub	D2	ChemEng	0	0.00	0 •		•	CENG06	0.701	544.44
Old Dominion University	3728	Pub	D2	ChemEng	0	0.00	0 •		•	CENG06	0.701	544.44
Portland State University	3216	Pub	D2	ChemEng	0	0.00	3	3	•	CENG06	0.701	544.44

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Table 5-A.8: Segmentation Array: Chemical Engineering

School	FICE	TOC	Carnegie Class	Academic Discipline	Faculty	Faculty (adjusted)	R&D Expenditures	R&D Exp (adjusted)	Factor Score	Segment	Segment RU Fraction	Segment Faculty
SUNY at Albany	2835	Pub	R2	ChemEng	0	0.00	0	•		• CENG06	0.701	544.44
SUNY at Binghamton	2836	Pub	D1	ChemEng	0	0.00	0	•		• CENG06	0.701	544.44
SUNY at Stony Brook, All Campuses	2838	Pub	R1	ChemEng	0	0.00	0	•		• CENG06	0.701	544.44
Temple University	3371	Pub	R2	ChemEng	0	0.00	0	•		• CENG06	0.701	544.44
Texas Woman's University	3646	Pub	D1	ChemEng	0	0.00	0	•		• CENG06	0.701	544.44
University of Alabama at Birmingham	1052	Pub	D2	ChemEng	0	0.00	0	•		• CENG06	0.701	544.44
University of California-Irvine	1314	Pub	R1	ChemEng	0	0.00	0	•		• CENG06	0.701	544.44
University of California-Riverside	1316	Pub	D1	ChemEng	0	0.00	0	•		• CENG06	0.701	544.44
University of California-San Diego	1317	Pub	R1	ChemEng	0	0.00	0	•		• CENG06	0.701	544.44
University of California-San Francisco	1319	Pub	R1	ChemEng	0	0.00	0	•		• CENG06	0.701	544.44
University of California-Santa Cruz	1321	Pub	D1	ChemEng	0	0.00	0	•		• CENG06	0.701	544.44
University of Georgia	1598	Pub	R1	ChemEng	0	0.00	0	•		• CENG06	0.701	544.44
University of Hawaii at Manoa	1610	Pub	R1	ChemEng	0	0.00	0	•		• CENG06	0.701	544.44
University of Illinois at Chicago	1776	Pub	R1	ChemEng	0	0.00	143	143		• CENG06	0.701	544.44
University of Maryland Baltimore County	2105	Pub	D2	ChemEng	0	0.00	0	•		• CENG06	0.701	544.44
University of Missouri, Kansas City	2518	Pub	D2	ChemEng	0	0.00	0	•		• CENG06	0.701	544.44
University of Missouri, Saint Louis	2519	Pub	D2	ChemEng	0	0.00	0	•		• CENG06	0.701	544.44
University of Montana	2536	Pub	D1	ChemEng	0	0.00	0	•		• CENG06	0.701	544.44
University of Nevada-Reno	2568	Pub	D2	ChemEng	0	0.00	13	13		• CENG06	0.701	544.44
University of New Orleans	2015	Pub	D2	ChemEng	0	0.00	0	•		• CENG06	0.701	544.44
University of North Carolina at Chapel Hill	2974	Pub	R1	ChemEng	0	0.00	0	•		• CENG06	0.701	544.44
University of North Carolina at Greensboro	2976	Pub	D2	ChemEng	0	0.00	0	•		• CENG06	0.701	544.44
University of North Texas	3594	Pub	D1	ChemEng	0	0.00	0	•		• CENG06	0.701	544.44
University of Northern Colorado	1349	Pub	D1	ChemEng	0	0.00	0	•		• CENG06	0.701	544.44
University of Oregon	3223	Pub	R2	ChemEng	0	0.00	0	•		• CENG06	0.701	544.44
University of South Dakota	3474	Pub	D2	ChemEng	0	0.00	0	•		• CENG06	0.701	544.44
University of Southern Mississippi	2441	Pub	D1	ChemEng	0	0.00	0	•		• CENG06	0.701	544.44
University of Texas at Arlington	3656	Pub	D2	ChemEng	0	0.00	0	•		• CENG06	0.701	544.44
University of Texas at Dallas	9741	Pub	D2	ChemEng	0	0.00	0	•		• CENG06	0.701	544.44
University of Vermont	3696	Pub	D2	ChemEng	0	0.00	0	•		• CENG06	0.701	544.44
University of Wisconsin-Milwaukee	3896	Pub	D1	ChemEng	0	0.00	0	•		• CENG06	0.701	544.44
Utah State University	3677	Pub	R2	ChemEng	0	0.00	0	•		• CENG06	0.701	544.44
Virginia Commonwealth University	3735	Pub	R2	ChemEng	0	0.00	0	•		• CENG06	0.701	544.44

Table 5-A.9: Segmentation Array: Civil Engineering

School	FICE	TOC	Carnegie Class	Academic Discipline	Faculty	Faculty (adjusted)	R&D Expenditures	R&D Exp (adjusted)	Factor Score	Segment	Segment RU Fraction	Segment Faculty
Polytechnic University	2796	Pri	D2	CivilEng	9	9.00	441	441	-3.64	CIVL01	0.905	168.04
California Institute of Technology	1131	Pri	R1	CivilEng	8	8.00	715	715	-2.77	CIVL01	0.905	168.04
Illinois Institute of Technology	1691	Pri	D1	CivilEng	7	7.00	72	72	-2.46	CIVL01	0.905	168.04
Washington University	2520	Pri	R1	CivilEng	7	7.00	107	107	-2.00	CIVL01	0.905	168.04
University of Southern California	1328	Pri	R1	CivilEng	16	16.00	975	975	-1.66	CIVL01	0.905	168.04
Stanford University	1305	Pri	R1	CivilEng	24	24.00	1,977	1,977	-1.65	CIVL01	0.905	168.04
Johns Hopkins University	2077	Pri	R1	CivilEng	5	5.00	119	119	-1.07	CIVL01	0.905	168.04
Rensselaer Polytechnic Institute	2803	Pri	R2	CivilEng	14	14.00	566	566	-1.00	CIVL01	0.905	168.04
Columbia University, Main Campus	2707	Pri	R1	CivilEng	10	10.00	594	594	-1.00	CIVL01	0.905	168.04
Massachusetts Institute of Technology	2178	Pri	R1	CivilEng	53	53.00	8,189	8,189	-0.96	CIVL01	0.905	168.04
George Washington University	1444	Pri	R2	CivilEng	0	15.04	254	254	-0.93	CIVL01	0.905	168.04
Cornell University, All Campuses	2711	Pri	R1	CivilEng	32	32.00	305	305	-0.74	CIVL02	0.610	362.74
Northeastern University	2199	Pri	D2	CivilEng	0	18.66	93	93	-0.58	CIVL02	0.610	362.74
Brigham Young University, Main Campus	3670	Pri	D1	CivilEng	0	11.93	113	113	-0.44	CIVL02	0.610	362.74
Catholic University of America	1437	Pri	D1	CivilEng	0	8.21	94	94	-0.38	CIVL02	0.610	362.74
Rice University	3604	Pri	D1	CivilEng	6	6.00	173	173	-0.34	CIVL02	0.610	362.74
Princeton University	2627	Pri	R1	CivilEng	20	20.00	1,172	1,172	-0.17	CIVL02	0.610	362.74
Drexel University	3256	Pri	D2	CivilEng	14	14.00	274	274	-0.16	CIVL02	0.610	362.74
Northwestern University	1739	Pri	R1	CivilEng	30	30.00	403	403	-0.12	CIVL02	0.610	362.74
University of Notre Dame	1840	Pri	D1	CivilEng	7	7.00	611	611	-0.04	CIVL02	0.610	362.74
Case Western Reserve University	3024	Pri	R1	CivilEng	0	6.97	352	352	-0.03	CIVL02	0.610	362.74
Clarkson University	2699	Pri	D2	CivilEng	0	14.98	366	366	-0.02	CIVL02	0.610	362.74
Vanderbilt University	3,535	Pri	R1	CivilEng	15	15.00	43	43	0.04	CIVL02	0.610	362.74
Tulane University of Louisiana	2029	Pri	R2	CivilEng	8	8.00	50	50	0.08	CIVL02	0.610	362.74
Harvard University	2155	Pri	R1	CivilEng	0	5.31	219	219	0.09	CIVL02	0.610	362.74
Southern Methodist University	3613	Pri	D2	CivilEng	0	2.84	59	59	0.11	CIVL02	0.610	362.74
Syracuse University, Main Campus	2882	Pri	R2	CivilEng	11	11.00	339	339	0.12	CIVL02	0.610	362.74
Carnegie Mellon University	3242	Pri	R1	CivilEng	19	19.00	389	389	0.12	CIVL02	0.610	362.74
Duke University	2920	Pri	R1	CivilEng	11	11.00	120	120	0.29	CIVL02	0.610	362.74
Marquette University	3863	Pri	D1	CivilEng	0	9.65	23	23	0.31	CIVL02	0.610	362.74
University of Pennsylvania	3378	Pri	R1	CivilEng	10	10.00	290	290	0.36	CIVL02	0.610	362.74
Lehigh University	3289	Pri	D1	CivilEng	19	19.00	14	14	0.37	CIVL02	0.610	362.74
University of Miami	1536	Pri	R1	CivilEng	0	9.90	303	303	0.40	CIVL02	0.610	362.74
Howard University	1448	Pri	R1	CivilEng	0	14.58	41	41	0.67	CIVL02	0.610	362.74
Tufts University	2219	Pri	D1	CivilEng	0	11.87	48	48	0.69	CIVL02	0.610	362.74
Brown University	3401	Pri	R2	CivilEng	8	8.00	297	297	1.08	CIVL02	0.610	362.74
University of Chicago	1774	Pri	R1	CivilEng	0	1.19	0	1	1.15	CIVL02	0.610	362.74
Florida Institute of Technology	1469	Pri	D2	CivilEng	0	1.93	0	2	1.17	CIVL02	0.610	362.74
Dartmouth College	2573	Pri	D2	CivilEng	0	2.84	88	88	1.22	CIVL02	0.610	362.74
Yale University	1426	Pri	R1	CivilEng	0	6.97	197	197	1.23	CIVL02	0.610	362.74
Loma Linda University	1218	Pri	D2	CivilEng	0	7.73	0	8	1.25	CIVL02	0.610	362.74
Emory University	1564	Pri	R2	CivilEng	0	9.65	0	10	1.26	CIVL02	0.610	362.74
Stevens Institute of Technology	2639	Pri	D2	CivilEng	0	3.72	0	4	1.29	CIVL02	0.610	362.74
Brandeis University	2133	Pri	R2	CivilEng	0	2.84	0	3	1.30	CIVL02	0.610	362.74

Table 5-A.9: Segmentation Array: Civil Engineering

School	FICE	TOC	Carnegie Class	Academic Discipline	Faculty	Faculty (adjusted)	R&D Expenditures	R&D Exp (adjusted)	Factor Score	Segment	Segment RU Fraction	Segment Faculty
Andrews University	2238	Pri	D2	CivilEng	0	0.98	0	1	1.30	CIVL02	0.610	362.74
Adelphi University	2666	Pri	D2	CivilEng	0	0.00	0	•	•	CIVL02	0.610	362.74
American University	1434	Pri	D1	CivilEng	0	0.00	0	•	•	CIVL02	0.610	362.74
Baylor University	6967	Pri	D2	CivilEng	0	0.00	0	•	•	CIVL02	0.610	362.74
Biola University	1122	Pri	D2	CivilEng	0	0.00	0	•	•	CIVL02	0.610	362.74
Boston College	2128	Pri	D1	CivilEng	0	0.00	0	•	•	CIVL02	0.610	362.74
Boston University	2130	Pri	R1	CivilEng	0	0.00	0	•	•	CIVL02	0.610	362.74
Claremont Univ Center & Graduate School	1169	Pri	D1	CivilEng	0	0.00	0	•	•	CIVL02	0.610	362.74
Clark Atlanta University	1559	Pri	D2	CivilEng	0	0.00	0	•	•	CIVL02	0.610	362.74
Clark University	2139	Pri	D2	CivilEng	0	0.00	0	•	•	CIVL02	0.610	362.74
Columbia University, Teachers College	3979	Pri	D1	CivilEng	0	0.00	0	•	•	CIVL02	0.610	362.74
Drake University	1860	Pri	D2	CivilEng	0	0.00	0	•	•	CIVL02	0.610	362.74
Duquesne University	3258	Pri	D2	CivilEng	0	0.00	0	•	•	CIVL02	0.610	362.74
Fordham University	2722	Pri	D1	CivilEng	0	0.00	0	•	•	CIVL02	0.610	362.74
Georgetown University	1445	Pri	R2	CivilEng	0	0.00	0	•	•	CIVL02	0.610	362.74
Hahnemann University	3271	Pri	D2	CivilEng	0	0.00	0	•	•	CIVL02	0.610	362.74
Hofstra University	2732	Pri	D2	CivilEng	0	0.00	0	•	•	CIVL02	0.610	362.74
Loyola University of Chicago	1710	Pri	D1	CivilEng	0	0.00	0	•	•	CIVL02	0.610	362.74
New School For Social Research	2780	Pri	D2	CivilEng	0	0.00	0	•	•	CIVL02	0.610	362.74
New York University	2785	Pri	R1	CivilEng	0	0.00	0	•	•	CIVL02	0.610	362.74
Nova University	1509	Pri	D1	CivilEng	0	0.00	0	•	•	CIVL02	0.610	362.74
Pepperdine University	1264	Pri	D2	CivilEng	0	0.00	0	•	•	CIVL02	0.610	362.74
Rockefeller University	2807	Pri	R1	CivilEng	0	0.00	0	•	•	CIVL02	0.610	362.74
Saint John's University New York	2823	Pri	D1	CivilEng	0	0.00	0	•	•	CIVL02	0.610	362.74
Saint Louis University, Main Campus	2506	Pri	D1	CivilEng	0	0.00	4	4	•	CIVL02	0.610	362.74
Texas Christian University	3636	Pri	D2	CivilEng	0	0.00	0	•	•	CIVL02	0.610	362.74
Union Institute	10923	Pri	D1	CivilEng	0	0.00	0	•	•	CIVL02	0.610	362.74
University of Denver	1371	Pri	D1	CivilEng	0	0.00	0	•	•	CIVL02	0.610	362.74
University of Rochester	2894	Pri	R1	CivilEng	0	0.00	0	•	•	CIVL02	0.610	362.74
University of San Francisco	1325	Pri	D2	CivilEng	0	0.00	0	•	•	CIVL02	0.610	362.74
University of Tulsa	3185	Pri	D2	CivilEng	0	0.00	0	•	•	CIVL02	0.610	362.74
Yeshiva University	2903	Pri	R1	CivilEng	0	0.00	0	•	•	CIVL02	0.610	362.74
University of Missouri, Columbia	2516	Pub	R1	CivilEng	9	9.00	165	165	-2.82	CIVL03	1.000	142.73
University of California-Irvine	1314	Pub	R1	CivilEng	0	0.73	0	1	-2.68	CIVL03	1.000	142.73
Pennsylvania State U, Main Campus	6965	Pub	R1	CivilEng	15	15.00	366	366	-2.64	CIVL03	1.000	142.73
University of California-Berkeley	1312	Pub	R1	CivilEng	57	57.00	5,319	5,319	-2.22	CIVL03	1.000	142.73
Ohio State University, Main Campus	6883	Pub	R1	CivilEng	14	14.00	527	527	-1.49	CIVL03	1.000	142.73
University of Oklahoma, Norman Campus	3184	Pub	R2	CivilEng	15	15.00	296	296	-1.46	CIVL03	1.000	142.73
University of New Mexico, All Campuses	10313	Pub	R1	CivilEng	16	16.00	5,894	5,894	-1.34	CIVL03	1.000	142.73
University of Florida	1535	Pub	R1	CivilEng	16	16.00	1,764	1,764	-1.27	CIVL03	1.000	142.73
Iowa State University	1869	Pub	R2	CivilEng	19	19.00	1,911	1,911	-1.19	CIVL04	1.000	262.00
Georgia Institute of Technology, Main Campus	1569	Pub	R1	CivilEng	31	31.00	2,405	2,405	-1.07	CIVL04	1.000	262.00
University of Arizona	1083	Pub	R1	CivilEng	14	14.00	160	160	-1.00	CIVL04	1.000	262.00
University of Tennessee at Knoxville	3530	Pub	R1	CivilEng	13	13.00	0	22	-0.96	CIVL04	1.000	262.00

Table 5-A.9: Segmentation Array: Civil Engineering

School	FICE	TOC	Carnegie Class	Academic Discipline	Faculty	Faculty (adjusted)	R&D Expenditures	R&D Exp (adjusted)	Factor Score	Segment	Segment RU Fraction	Segment Faculty
Michigan State University	2290	Pub	R1	CivilEng	17	17.00	71	71	-0.93	CIVL04	1.000	262.00
Oklahoma State University, All Campuses	3170	Pub	R2	CivilEng	18	18.00	664	664	-0.90	CIVL04	1.000	262.00
Texas A & M University, Main Campus	10366	Pub	R1	CivilEng	39	39.00	1,779	1,779	-0.87	CIVL04	1.000	262.00
University of Minnesota at Twin Cities	3969	Pub	R1	CivilEng	17	17.00	597	597	-0.86	CIVL04	1.000	262.00
University of Michigan at Ann Arbor	9092	Pub	R1	CivilEng	23	23.00	1,293	1,293	-0.74	CIVL04	1.000	262.00
Purdue University, Main Campus	1825	Pub	R1	CivilEng	54	54.00	2,156	2,156	-0.71	CIVL04	1.000	262.00
University of Pittsburgh Main Campus	3379	Pub	R1	CivilEng	17	17.00	430	430	-0.70	CIVL04	1.000	262.00
Texas Tech University	3644	Pub	D1	CivilEng	11	11.00	638	638	-0.67	CIVL05	0.790	243.00
University of Texas at Austin	3658	Pub	R1	CivilEng	42	42.00	2,728	2,728	-0.64	CIVL05	0.790	243.00
University of Texas at Arlington	3656	Pub	D2	CivilEng	14	14.00	6	6	-0.63	CIVL05	0.790	243.00
University of Houston-University Park	3652	Pub	D1	CivilEng	13	13.00	460	460	-0.58	CIVL05	0.790	243.00
University of Illinois at Urbana-Champaign	1775	Pub	R1	CivilEng	67	67.00	2,607	2,607	-0.57	CIVL05	0.790	243.00
Clemson University	3425	Pub	D1	CivilEng	13	13.00	855	855	-0.51	CIVL05	0.790	243.00
SUNY at Buffalo, Main Campus	2837	Pub	R2	CivilEng	15	15.00	419	419	-0.46	CIVL05	0.790	243.00
Colorado State University	1350	Pub	R1	CivilEng	49	49.00	1,213	1,213	-0.44	CIVL05	0.790	243.00
University of Massachusetts at Amherst	2221	Pub	R2	CivilEng	19	19.00	517	517	-0.43	CIVL05	0.790	243.00
University of Virginia, Main Campus	6968	Pub	R1	CivilEng	15	15.00	255	255	-0.36	CIVL06	0.687	917.37
Virginia Polytechnic Institute and State Univ	3754	Pub	R1	CivilEng	29	29.00	1,682	1,682	-0.34	CIVL06	0.687	917.37
Montana State University	2532	Pub	D2	CivilEng	0	6.93	828	828	-0.26	CIVL06	0.687	917.37
University of Idaho	1626	Pub	D2	CivilEng	0	8.46	104	104	-0.18	CIVL06	0.687	917.37
University of Kansas, Main Campus	1948	Pub	R2	CivilEng	23	23.00	236	236	-0.16	CIVL06	0.687	917.37
University of California-Davis	1313	Pub	R1	CivilEng	25	25.00	1,070	1,070	-0.13	CIVL06	0.687	917.37
University of Washington	3798	Pub	R1	CivilEng	42	42.00	1,391	1,391	-0.13	CIVL06	0.687	917.37
University of Missouri, Rolla	2517	Pub	D2	CivilEng	21	21.00	678	678	-0.11	CIVL06	0.687	917.37
University of Cincinnati, All Campuses	3125	Pub	R1	CivilEng	14	14.00	279	279	-0.10	CIVL06	0.687	917.37
North Carolina State University at Raleigh	2972	Pub	R1	CivilEng	30	30.00	962	962	-0.10	CIVL06	0.687	917.37
Wayne State University	2329	Pub	R2	CivilEng	9	9.00	166	166	-0.07	CIVL06	0.687	917.37
University of Maryland at College Park	2103	Pub	R1	CivilEng	19	19.00	457	457	-0.05	CIVL06	0.687	917.37
Mississippi State University	2423	Pub	R2	CivilEng	0	13.67	139	139	-0.03	CIVL06	0.687	917.37
University of Colorado at Boulder	1370	Pub	R1	CivilEng	23	23.00	532	532	0.06	CIVL06	0.687	917.37
West Virginia University	3827	Pub	R2	CivilEng	16	16.00	82	82	0.06	CIVL06	0.687	917.37
Rutgers, the State University at New Brunswick	6964	Pub	R1	CivilEng	13	13.00	258	258	0.08	CIVL06	0.687	917.37
University of Wisconsin-Madison	3895	Pub	R1	CivilEng	29	29.00	576	576	0.11	CIVL06	0.687	917.37
University of Akron, All Campuses	3123	Pub	D1	CivilEng	0	9.52	66	66	0.13	CIVL06	0.687	917.37
University of Utah	3675	Pub	R1	CivilEng	10	10.00	938	938	0.14	CIVL06	0.687	917.37
SUNY College of Environmental Science and F	2851	Pub	D2	CivilEng	0	5.40	0	5	0.15	CIVL06	0.687	917.37
Oregon State University	3210	Pub	R1	CivilEng	20	20.00	836	836	0.24	CIVL06	0.687	917.37
Auburn University, Main Campus	1009	Pub	R2	CivilEng	0	13.07	131	131	0.24	CIVL06	0.687	917.37
Arizona State University	1081	Pub	R2	CivilEng	0	11.93	73	73	0.27	CIVL06	0.687	917.37
Temple University	3371	Pub	R2	CivilEng	0	6.08	0	6	0.29	CIVL06	0.687	917.37
University of Iowa	1892	Pub	R1	CivilEng	19	19.00	352	352	0.30	CIVL06	0.687	917.37
Kansas State University of Agriculture and App	1928	Pub	R2	CivilEng	0	13.36	223	223	0.34	CIVL06	0.687	917.37
University of California-Los Angeles	1315	Pub	R1	CivilEng	22	22.00	75	75	0.36	CIVL06	0.687	917.37
Washington State University	3800	Pub	R2	CivilEng	0	17.58	397	397	0.40	CIVL06	0.687	917.37

Table 5-A.9: Segmentation Array: Civil Engineering

School	FICE	TOC	Carnegie Class	Academic Discipline	Faculty	Faculty (adjusted)	R&D Expenditures	R&D Exp (adjusted)	Factor Score	Segment	Segment RU Fraction	Segment Faculty
University of Kentucky, Main Campus	1989	Pub	R1	CivilEng	0	21.13	634	634	0.42	CIVL06	0.687	917.37
Cleveland State University	3032	Pub	D2	CivilEng	0	8.98	38	38	0.47	CIVL06	0.687	917.37
University of Mississippi, Main Campus	2440	Pub	D1	CivilEng	0	7.72	252	252	0.47	CIVL06	0.687	917.37
University of Hawaii at Manoa	1610	Pub	R1	CivilEng	0	15.86	104	104	0.48	CIVL06	0.687	917.37
New Mexico State University, All Campuses	2657	Pub	R1	CivilEng	0	16.35	2,436	2,436	0.49	CIVL06	0.687	917.37
Utah State University	3677	Pub	R2	CivilEng	20	20.00	209	209	0.50	CIVL06	0.687	917.37
Memphis State University	3509	Pub	D1	CivilEng	0	8.46	42	42	0.51	CIVL06	0.687	917.37
Tennessee Technological University	3523	Pub	D2	CivilEng	0	9.90	49	49	0.55	CIVL06	0.687	917.37
University of Nebraska at Lincoln	2565	Pub	R2	CivilEng	0	21.57	146	146	0.56	CIVL06	0.687	917.37
University of Delaware	1431	Pub	R2	CivilEng	0	14.60	456	456	0.57	CIVL06	0.687	917.37
University of New Hampshire, Main Campus	2589	Pub	D2	CivilEng	0	11.39	145	145	0.58	CIVL06	0.687	917.37
University of Maine at Orono	2053	Pub	D2	CivilEng	0	9.86	14	14	0.60	CIVL06	0.687	917.37
Northern Arizona University	1082	Pub	D2	CivilEng	0	5.31	0	5	0.61	CIVL06	0.687	917.37
University of Arkansas, Main Campus	1108	Pub	D1	CivilEng	0	11.83	759	759	0.63	CIVL06	0.687	917.37
University of Toledo	3131	Pub	D1	CivilEng	0	8.50	60	60	0.64	CIVL06	0.687	917.37
University of Connecticut, Main Campus	29013	Pub	R1	CivilEng	18	18.00	461	461	0.66	CIVL06	0.687	917.37
North Dakota State University, All Campuses	9265	Pub	D2	CivilEng	0	13.07	12	12	0.67	CIVL06	0.687	917.37
University of Vermont	3696	Pub	D2	CivilEng	0	9.19	42	42	0.81	CIVL06	0.687	917.37
Ohio University, All Campuses	3100	Pub	D1	CivilEng	0	5.40	61	61	0.82	CIVL06	0.687	917.37
Old Dominion University	3728	Pub	D2	CivilEng	0	10.59	42	42	0.83	CIVL06	0.687	917.37
University of Wisconsin-Milwaukee	3898	Pub	D1	CivilEng	0	25.69	294	294	0.83	CIVL06	0.687	917.37
University of Louisville	1999	Pub	D1	CivilEng	0	12.46	57	57	0.84	CIVL06	0.687	917.37
University of Alabama	1051	Pub	D1	CivilEng	0	15.20	115	115	0.84	CIVL06	0.687	917.37
University of Wyoming	3932	Pub	R2	CivilEng	0	13.07	103	103	0.84	CIVL06	0.687	917.37
University of New Orleans	2015	Pub	D2	CivilEng	0	6.37	49	49	0.87	CIVL06	0.687	917.37
Portland State University	3216	Pub	D2	CivilEng	0	8.70	4	4	0.89	CIVL06	0.687	917.37
Louisiana Tech University	2008	Pub	D2	CivilEng	0	9.90	51	51	0.92	CIVL06	0.687	917.37
University of North Carolina at Chapel Hill	2974	Pub	R1	CivilEng	0	18.98	0	19	0.92	CIVL06	0.687	917.37
University of North Dakota, All Campuses	3005	Pub	D2	CivilEng	0	5.40	185	185	0.95	CIVL06	0.687	917.37
University of South Carolina at Columbia	3448	Pub	R2	CivilEng	0	15.38	71	71	0.96	CIVL06	0.687	917.37
University of Rhode Island	3414	Pub	R2	CivilEng	9	9.00	316	316	1.10	CIVL06	0.687	917.37
Indiana University at Bloomington	1809	Pub	R1	CivilEng	0	0.73	0	1	1.20	CIVL06	0.687	917.37
University of South Florida	1537	Pub	D1	CivilEng	0	7.72	0	8	1.26	CIVL06	0.687	917.37
University of Alabama at Birmingham	1052	Pub	D2	CivilEng	0	6.13	42	42	1.27	CIVL06	0.687	917.37
Southern Illinois University-Carbondale	1758	Pub	R2	CivilEng	0	11.19	20	20	1.27	CIVL06	0.687	917.37
Colorado School of Mines	1348	Pub	D2	CivilEng	0	9.17	0	9	1.28	CIVL06	0.687	917.37
Kent State University, All Campuses	3051	Pub	D1	CivilEng	0	2.84	0	3	1.30	CIVL06	0.687	917.37
Miami University, All Campuses	7104	Pub	D1	CivilEng	0	2.84	0	3	1.30	CIVL06	0.687	917.37
Idaho State University	1620	Pub	D2	CivilEng	0	0.98	0	1	1.30	CIVL06	0.687	917.37
Middle Tennesse State University	3510	Pub	D2	CivilEng	0	0.98	0	1	1.30	CIVL06	0.687	917.37
Northern Illinois University	1737	Pub	D1	CivilEng	0	0.98	0	1	1.30	CIVL06	0.687	917.37
University of Georgia	1598	Pub	R1	CivilEng	0	0.98	0	1	1.30	CIVL06	0.687	917.37
Ball State University	1786	Pub	D1	CivilEng	0	0.00	0 •		•	CIVL06	0.687	917.37
Bowling Green State University, All Campuses	3018	Pub	D1	CivilEng	0	0.00	0 •		•	CIVL06	0.687	917.37

Table 5-A.9: Segmentation Array: Civil Engineering

School	FICE	TOC	Carnegie Class	Academic Discipline	Faculty	Faculty (adjusted)	R&D Expenditures	R&D Exp (adjusted)	Factor Score	Segment	Segment RU Fraction	Segment Faculty
College of William and Mary	3705	Pub	D1	CivilEng	0	0.00	0	•		• CIVL06	0.687	917.37
CUNY Graduate School and University Center	4063	Pub	D1	CivilEng	0	0.00	0	•		• CIVL06	0.687	917.37
East Texas State University, All Campuses	3565	Pub	D2	CivilEng	0	0.00	0	•		• CIVL06	0.687	917.37
Florida Atlantic University	1481	Pub	D2	CivilEng	0	0.00	0	•		• CIVL06	0.687	917.37
Florida State University	1489	Pub	R2	CivilEng	0	0.00	0	•		• CIVL06	0.687	917.37
Georgia State University	1574	Pub	D1	CivilEng	0	0.00	0	•		• CIVL06	0.687	917.37
Illinois State University	1692	Pub	D2	CivilEng	0	0.00	0	•		• CIVL06	0.687	917.37
Indiana State University, Terre Haute	9563	Pub	D2	CivilEng	0	0.00	0	•		• CIVL06	0.687	917.37
Louisiana State University and Agric & Mech Cc	2010	Pub	R1	CivilEng	0	0.00	0	•		• CIVL06	0.687	917.37
SUNY at Albany	2835	Pub	R2	CivilEng	0	0.00	0	•		• CIVL06	0.687	917.37
SUNY at Binghamton	2836	Pub	D1	CivilEng	0	0.00	0	•		• CIVL06	0.687	917.37
SUNY at Stony Brook, All Campuses	2838	Pub	R1	CivilEng	0	0.00	0	•		• CIVL06	0.687	917.37
Texas Woman's University	3646	Pub	D1	CivilEng	0	0.00	0	•		• CIVL06	0.687	917.37
University of California-Riverside	1316	Pub	D1	CivilEng	0	0.00	0	•		• CIVL06	0.687	917.37
University of California-San Diego	1317	Pub	R1	CivilEng	0	0.00	0	•		• CIVL06	0.687	917.37
University of California-San Francisco	1319	Pub	R1	CivilEng	0	0.00	0	•		• CIVL06	0.687	917.37
University of California-Santa Barbara	1320	Pub	R2	CivilEng	0	0.00	0	•		• CIVL06	0.687	917.37
University of California-Santa Cruz	1321	Pub	D1	CivilEng	0	0.00	0	•		• CIVL06	0.687	917.37
University of Illinois at Chicago	1776	Pub	R1	CivilEng	0	0.00	218	218		• CIVL06	0.687	917.37
University of Maryland Baltimore County	2105	Pub	D2	CivilEng	0	0.00	0	•		• CIVL06	0.687	917.37
University of Missouri, Kansas City	2518	Pub	D2	CivilEng	0	0.00	0	•		• CIVL06	0.687	917.37
University of Missouri, Saint Louis	2519	Pub	D2	CivilEng	0	0.00	0	•		• CIVL06	0.687	917.37
University of Montana	2536	Pub	D1	CivilEng	0	0.00	0	•		• CIVL06	0.687	917.37
University of Nevada-Reno	2568	Pub	D2	CivilEng	0	0.00	47	47		• CIVL06	0.687	917.37
University of North Carolina at Greensboro	2976	Pub	D2	CivilEng	0	0.00	0	•		• CIVL06	0.687	917.37
University of North Texas	3594	Pub	D1	CivilEng	0	0.00	0	•		• CIVL06	0.687	917.37
University of Northern Colorado	1349	Pub	D1	CivilEng	0	0.00	0	•		• CIVL06	0.687	917.37
University of Oregon	3223	Pub	R2	CivilEng	0	0.00	0	•		• CIVL06	0.687	917.37
University of South Dakota	3474	Pub	D2	CivilEng	0	0.00	0	•		• CIVL06	0.687	917.37
University of Southern Mississippi	2441	Pub	D1	CivilEng	0	0.00	0	•		• CIVL06	0.687	917.37
University of Texas at Dallas	9741	Pub	D2	CivilEng	0	0.00	0	•		• CIVL06	0.687	917.37
Virginia Commonwealth University	3735	Pub	R2	CivilEng	0	0.00	0	•		• CIVL06	0.687	917.37
Western Michigan University	2330	Pub	D1	CivilEng	0	0.00	2	2		• CIVL06	0.687	917.37

Table 5-A.10: Segmentation Array: Electrical Engineering

School	FICE	TOC	Carnegie Class	Academic Discipline	Faculty	Faculty (adjusted)	R&D Expenditures	R&D Exp (adjusted)	Factor Score	Segment	Segment RU Fraction	Segment Faculty
Massachusetts Institute of Technology	2178	Pri	R1	ElecEng	53	53.00	19,251	19,251	-3.25	ELEC01	0.741	85.00
Princeton University	2627	Pri	R1	ElecEng	10	10.00	348	348	-2.94	ELEC01	0.741	85.00
Illinois Institute of Technology	1691	Pri	D1	ElecEng	9	9.00	121	121	-2.87	ELEC01	0.741	85.00
Southern Methodist University	3613	Pri	D2	ElecEng	13	13.00	189	189	-2.37	ELEC01	0.741	85.00
Stanford University	1305	Pri	R1	ElecEng	61	61.00	13,588	13,588	-2.27	ELEC02	0.806	108.00
Polytechnic University	2796	Pri	D2	ElecEng	21	21.00	1,362	1,362	-2.12	ELEC02	0.806	108.00
California Institute of Technology	1131	Pri	R1	ElecEng	13	13.00	2,296	2,296	-1.92	ELEC02	0.806	108.00
Johns Hopkins University	2077	Pri	R1	ElecEng	13	13.00	139	139	-1.76	ELEC02	0.806	108.00
Carnegie Mellon University	3242	Pri	R1	ElecEng	24	24.00	1,644	1,644	-1.56	ELEC03	0.826	178.00
Catholic University of America	1437	Pri	D1	ElecEng	5	5.00	235	235	-1.27	ELEC03	0.826	178.00
Columbia University, Main Campus	2707	Pri	R1	ElecEng	15	15.00	1,785	1,785	-1.20	ELEC03	0.826	178.00
University of Pennsylvania	3378	Pri	R1	ElecEng	15	15.00	1,317	1,317	-1.16	ELEC03	0.826	178.00
Cornell University, All Campuses	2711	Pri	R1	ElecEng	35	35.00	4,900	4,900	-1.05	ELEC03	0.826	178.00
Rice University	3604	Pri	D1	ElecEng	16	16.00	437	437	-0.87	ELEC03	0.826	178.00
University of Notre Dame	1840	Pri	D1	ElecEng	10	10.00	306	306	-0.87	ELEC03	0.826	178.00
University of Southern California	1328	Pri	R1	ElecEng	58	58.00	4,009	4,009	-0.87	ELEC03	0.826	178.00
Rensselaer Polytechnic Institute	2803	Pri	R2	ElecEng	39	39.00	2,310	2,310	-0.72	ELEC04	0.611	530.34
Northeastern University	2199	Pri	D2	ElecEng	25	25.00	831	831	-0.63	ELEC04	0.611	530.34
Case Western Reserve University	3024	Pri	R1	ElecEng	16	16.00	992	992	-0.57	ELEC04	0.611	530.34
George Washington University	1444	Pri	R2	ElecEng	0	31.68	835	835	-0.33	ELEC04	0.611	530.34
Washington University	2520	Pri	R1	ElecEng	15	15.00	671	671	-0.33	ELEC04	0.611	530.34
Vanderbilt University	3535	Pri	R1	ElecEng	10	10.00	230	230	-0.31	ELEC04	0.611	530.34
Duke University	2920	Pri	R1	ElecEng	12	12.00	351	351	-0.28	ELEC04	0.611	530.34
Drexel University	3256	Pri	D2	ElecEng	23	23.00	225	225	-0.20	ELEC04	0.611	530.34
Lehigh University	3289	Pri	D1	ElecEng	0	13.14	56	56	-0.16	ELEC04	0.611	530.34
Clarkson University	2699	Pri	D2	ElecEng	19	19.00	927	927	0.06	ELEC04	0.611	530.34
Syracuse University, Main Campus	2882	Pri	R2	ElecEng	32	32.00	1,062	1,062	0.10	ELEC04	0.611	530.34
Stevens Institute of Technology	2639	Pri	D2	ElecEng	0	16.22	43	43	0.18	ELEC04	0.611	530.34
Brigham Young University, Main Campus	3670	Pri	D1	ElecEng	0	11.29	313	313	0.21	ELEC04	0.611	530.34
Harvard University	2155	Pri	R1	ElecEng	0	4.40	692	692	0.28	ELEC04	0.611	530.34
Northwestern University	1739	Pri	R1	ElecEng	40	40.00	1,307	1,307	0.33	ELEC04	0.611	530.34
Brown University	3401	Pri	R2	ElecEng	13	13.00	948	948	0.41	ELEC04	0.611	530.34
Marquette University	3863	Pri	D1	ElecEng	21	21.00	75	75	0.51	ELEC04	0.611	530.34
Florida Institute of Technology	1469	Pri	D2	ElecEng	0	13.92	46	46	0.54	ELEC04	0.611	530.34
University of Miami	1536	Pri	R1	ElecEng	0	10.76	63	63	0.57	ELEC04	0.611	530.34
University of Rochester	2894	Pri	R1	ElecEng	12	12.00	1,138	1,138	0.61	ELEC04	0.611	530.34
Tufts University	2219	Pri	D1	ElecEng	0	11.67	161	161	0.72	ELEC04	0.611	530.34
University of Tulsa	3185	Pri	D2	ElecEng	0	6.33	0	6	0.84	ELEC04	0.611	530.34
Howard University	1448	Pri	R1	ElecEng	0	19.58	302	302	0.87	ELEC04	0.611	530.34
Tulane University of Louisiana	2029	Pri	R2	ElecEng	0	7.28	154	154	0.95	ELEC04	0.611	530.34
University of Denver	1371	Pri	D1	ElecEng	0	10.72	2,071	2,071	0.99	ELEC04	0.611	530.34
Hofstra University	2732	Pri	D2	ElecEng	0	8.82	0	9	1.07	ELEC04	0.611	530.34
Hahnemann University	3271	Pri	D2	ElecEng	0	0.98	0	1	1.11	ELEC04	0.611	530.34
Dartmouth College	2573	Pri	D2	ElecEng	0	7.23	275	275	1.13	ELEC04	0.611	530.34

Table 5-A.10: Segmentation Array: Electrical Engineering

School	FICE	TOC	Carnegie Class	Academic Discipline	Faculty	Faculty (adjusted)	R&D Expenditures	R&D Exp (adjusted)	Factor Score	Segment	Segment RU Fraction	Segment Faculty
Yale University	1426	Pri	R1	ElecEng	18	18.00	651	651	1.17	ELEC04	0.611	530.34
Loma Linda University	1218	Pri	D2	ElecEng	0	14.86	0	15	1.19	ELEC04	0.611	530.34
Emory University	1564	Pri	R2	ElecEng	0	18.00	0	18	1.20	ELEC04	0.611	530.34
University of Chicago	1774	Pri	R1	ElecEng	0	17.76	0	18	1.22	ELEC04	0.611	530.34
Saint Louis University, Main Campus	2506	Pri	D1	ElecEng	0	0.97	10	10	1.22	ELEC04	0.611	530.34
Brandeis University	2133	Pri	R2	ElecEng	0	5.90	0	6	1.23	ELEC04	0.611	530.34
Yeshiva University	2903	Pri	R1	ElecEng	0	1.90	0	2	1.23	ELEC04	0.611	530.34
Andrews University	2238	Pri	D2	ElecEng	0	0.97	0	1	1.23	ELEC04	0.611	530.34
Baylor University	6967	Pri	D2	ElecEng	0	0.97	0	1	1.23	ELEC04	0.611	530.34
Adelphi University	2666	Pri	D2	ElecEng	0 •		0 •		•	ELEC04	0.611	530.34
American University	1434	Pri	D1	ElecEng	0 •		0 •		•	ELEC04	0.611	530.34
Biola University	1122	Pri	D2	ElecEng	0 •		0 •		•	ELEC04	0.611	530.34
Boston College	2128	Pri	D1	ElecEng	0 •		0 •		•	ELEC04	0.611	530.34
Boston University	2130	Pri	R1	ElecEng	0 •		100	100	•	ELEC04	0.611	530.34
Claremont Univ Center & Graduate School	1169	Pri	D1	ElecEng	0 •		0 •		•	ELEC04	0.611	530.34
Clark Atlanta University	1559	Pri	D2	ElecEng	0	•	0	•	•	ELEC04	0.611	530.34
Clark University	2139	Pri	D2	ElecEng	0 •		0 •		•	ELEC04	0.611	530.34
Columbia University, Teachers College	3979	Pri	D1	ElecEng	0 •		0 •		•	ELEC04	0.611	530.34
Drake University	1860	Pri	D2	ElecEng	0 •		0 •		•	ELEC04	0.611	530.34
Duquesne University	3258	Pri	D2	ElecEng	0 •		0 •		•	ELEC04	0.611	530.34
Fordham University	2722	Pri	D1	ElecEng	0 •		0 •		•	ELEC04	0.611	530.34
Georgetown University	1445	Pri	R2	ElecEng	0 •		0 •		•	ELEC04	0.611	530.34
Loyola University of Chicago	1710	Pri	D1	ElecEng	0 •		0 •		•	ELEC04	0.611	530.34
New School For Social Research	2780	Pri	D2	ElecEng	0 •		0 •		•	ELEC04	0.611	530.34
New York University	2785	Pri	R1	ElecEng	0 •		0 •		•	ELEC04	0.611	530.34
Nova University	1509	Pri	D1	ElecEng	0 •		0 •		•	ELEC04	0.611	530.34
Pepperdine University	1264	Pri	D2	ElecEng	0 •		0 •		•	ELEC04	0.611	530.34
Rockefeller University	2807	Pri	R1	ElecEng	0 •		0 •		•	ELEC04	0.611	530.34
Saint John's University New York	2823	Pri	D1	ElecEng	0 •		0 •		•	ELEC04	0.611	530.34
Texas Christian University	3636	Pri	D2	ElecEng	0 •		0 •		•	ELEC04	0.611	530.34
Union Institute	10923	Pri	D1	ElecEng	0 •		0 •		•	ELEC04	0.611	530.34
University of San Francisco	1325	Pri	D2	ElecEng	0 •		0 •		•	ELEC04	0.611	530.34
Georgia Institute of Technology, Main Campus	1569	Pub	R1	ElecEng	22	22.00	19,641	19,641	-3.31	ELEC05	1.000	106.00
University of California-Santa Barbara	1320	Pub	R2	ElecEng	21	21.00	291	291	-2.02	ELEC05	1.000	106.00
University of Missouri, Columbia	2516	Pub	R1	ElecEng	15	15.00	165	165	-1.91	ELEC05	1.000	106.00
University of California-Berkeley	1312	Pub	R1	ElecEng	48	48.00	6,956	6,956	-1.89	ELEC05	1.000	106.00
Purdue University, Main Campus	1825	Pub	R1	ElecEng	55	55.00	3,537	3,537	-1.38	ELEC06	1.000	145.00
Auburn University, Main Campus	1009	Pub	R2	ElecEng	13	13.00	363	363	-1.33	ELEC06	1.000	145.00
University of Oklahoma, Norman Campus	3184	Pub	R2	ElecEng	15	15.00	465	465	-1.29	ELEC06	1.000	145.00
University of Cincinnati, All Campuses	3125	Pub	R1	ElecEng	15	15.00	447	447	-1.26	ELEC06	1.000	145.00
SUNY at Stony Brook, All Campuses	2838	Pub	R1	ElecEng	14	14.00	100	100	-1.22	ELEC06	1.000	145.00
SUNY at Buffalo, Main Campus	2837	Pub	R2	ElecEng	20	20.00	973	973	-1.00	ELEC06	1.000	145.00
Rutgers, the State University at New Brunswick	6964	Pub	R1	ElecEng	13	13.00	410	410	-1.00	ELEC06	1.000	145.00
University of Houston-University Park	3652	Pub	D1	ElecEng	12	12.00	656	656	-0.93	ELEC07	0.832	149.00

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Table 5-A.10: Segmentation Array: Electrical Engineering

School	FICE	TOC	Carnegie Class	Academic Discipline	Faculty	Faculty (adjusted)	R&D Expenditures	R&D Exp (adjusted)	Factor Score	Segment	Segment RU Fraction	Segment Faculty
Oregon State University	3210	Pub	R1	ElecEng	17	17.00	325	325	-0.91	ELEC07	0.832	149.00
University of Pittsburgh Main Campus	3379	Pub	R1	ElecEng	20	20.00	699	699	-0.85	ELEC07	0.832	149.00
University of Texas at Arlington	3658	Pub	D2	ElecEng	13	13.00	282	282	-0.79	ELEC07	0.832	149.00
University of Illinois at Urbana-Champaign	1775	Pub	R1	ElecEng	87	87.00	3,654	3,654	-0.78	ELEC07	0.832	149.00
Iowa State University	1869	Pub	R2	ElecEng	15	15.00	1,083	1,083	-0.64	ELEC08	0.963	243.16
University of Texas at Austin	3658	Pub	R1	ElecEng	37	37.00	2,736	2,736	-0.63	ELEC08	0.963	243.16
Ohio University, All Campuses	3100	Pub	D1	ElecEng	9	9.00	815	815	-0.56	ELEC08	0.963	243.16
University of Virginia, Main Campus	6968	Pub	R1	ElecEng	14	14.00	876	876	-0.54	ELEC08	0.963	243.16
University of Utah	3675	Pub	R1	ElecEng	12	12.00	1,552	1,552	-0.52	ELEC08	0.963	243.16
Texas A & M University, Main Campus	10366	Pub	R1	ElecEng	18	18.00	1,009	1,009	-0.46	ELEC08	0.963	243.16
University of Delaware	1431	Pub	R2	ElecEng	0	9.16	300	300	-0.45	ELEC08	0.963	243.16
University of Michigan at Ann Arbor	9092	Pub	R1	ElecEng	51	51.00	2,644	2,644	-0.37	ELEC08	0.963	243.16
Arizona State University	1,081	Pub	R2	ElecEng	15	15.00	28	28	-0.37	ELEC08	0.963	243.16
University of Minnesota at Twin Cities	3969	Pub	R1	ElecEng	37	37.00	1,015	1,015	-0.32	ELEC08	0.963	243.16
University of Connecticut, Main Campus	29013	Pub	R1	ElecEng	12	12.00	1,130	1,130	-0.27	ELEC08	0.963	243.16
Oklahoma State University, All Campuses	3170	Pub	R2	ElecEng	14	14.00	1,081	1,081	-0.27	ELEC08	0.963	243.16
Ohio State University, Main Campus	6883	Pub	R1	ElecEng	51	51.00	2,949	2,949	-0.18	ELEC09	0.877	393.58
University of New Mexico, All Campuses	10313	Pub	R1	ElecEng	23	23.00	292	292	-0.17	ELEC09	0.877	393.58
New Mexico State University, All Campuses	2657	Pub	R1	ElecEng	19	19.00	4,080	4,080	-0.16	ELEC09	0.877	393.58
University of Wisconsin-Madison	3895	Pub	R1	ElecEng	28	28.00	1,025	1,025	-0.15	ELEC09	0.877	393.58
University of Maryland at College Park	2103	Pub	R1	ElecEng	28	28.00	731	731	-0.15	ELEC09	0.877	393.58
Colorado State University	1350	Pub	R1	ElecEng	16	16.00	1991	1991	-0.14	ELEC09	0.877	393.58
University of Kansas, Main Campus	1948	Pub	R2	ElecEng	20	20.00	396	396	-0.07	ELEC09	0.877	393.58
University of Missouri, Rolla	2517	Pub	D2	ElecEng	25	25.00	452	452	0.01	ELEC09	0.877	393.58
University of Iowa	1892	Pub	R1	ElecEng	13	13.00	587	587	0.04	ELEC09	0.877	393.58
Pennsylvania State U, Main Campus	6965	Pub	R1	ElecEng	25	25.00	735	735	0.05	ELEC09	0.877	393.58
University of Florida	1535	Pub	R1	ElecEng	36	36.00	2,719	2,719	0.07	ELEC09	0.877	393.58
Virginia Polytechnic Institute and State Univ	3754	Pub	R1	ElecEng	35	35.00	1,203	1,203	0.07	ELEC09	0.877	393.58
Clemson University	3425	Pub	D1	ElecEng	0	13.84	831	831	0.08	ELEC09	0.877	393.58
Michigan State University	2290	Pub	R1	ElecEng	24	24.00	342	342	0.12	ELEC09	0.877	393.58
University of Vermont	3696	Pub	D2	ElecEng	0	9.60	242	242	0.16	ELEC09	0.877	393.58
University of Wyoming	3932	Pub	R2	ElecEng	0	10.14	168	168	0.18	ELEC09	0.877	393.58
University of Arizona	1083	Pub	R1	ElecEng	17	17.00	607	607	0.19	ELEC09	0.877	393.58
North Carolina State University at Raleigh	2972	Pub	R1	ElecEng	29	29.00	1,518	1,518	0.19	ELEC10	0.639	834.02
University of Massachusetts at Amherst	2221	Pub	R2	ElecEng	18	18.00	365	365	0.21	ELEC10	0.639	834.02
University of California-Los Angeles	1315	Pub	R1	ElecEng	51	51.00	3,915	3,915	0.21	ELEC10	0.639	834.02
University of Washington	3798	Pub	R1	ElecEng	37	37.00	435	435	0.21	ELEC10	0.639	834.02
University of Rhode Island	3414	Pub	R2	ElecEng	16	16.00	504	504	0.23	ELEC10	0.639	834.02
University of Nebraska at Lincoln	2565	Pub	R2	ElecEng	0	11.39	90	90	0.27	ELEC10	0.639	834.02
University of Illinois at Chicago	1776	Pub	R1	ElecEng	21	21.00	360	360	0.28	ELEC10	0.639	834.02
Kansas State University of Agriculture and App	1928	Pub	R2	ElecEng	0	16.46	216	216	0.29	ELEC10	0.639	834.02
Florida Atlantic University	1481	Pub	D2	ElecEng	0	7.82	44	44	0.31	ELEC10	0.639	834.02
University of Arkansas, Main Campus	1108	Pub	D1	ElecEng	0	11.91	787	787	0.34	ELEC10	0.639	834.02
West Virginia University	3827	Pub	R2	ElecEng	16	16.00	49	49	0.35	ELEC10	0.639	834.02

Table 5-A.10: Segmentation Array: Electrical Engineering

School	FICE	TOC	Carnegie Class	Academic Discipline	Faculty	Faculty (adjusted)	R&D Expenditures	R&D Exp (adjusted)	Factor Score	Segment	Segment RU Fraction	Segment Faculty
University of California-Davis	1313	Pub	R1	ElecEng	19	19.00	555	555	0.36	ELEC10	0.639	834.02
Wayne State University	2329	Pub	R2	ElecEng	11	11.00	578	578	0.36	ELEC10	0.639	834.02
University of Tennessee at Knoxville	3530	Pub	R1	ElecEng	22	22.00	0	31	0.37	ELEC10	0.639	834.02
Cleveland State University	3032	Pub	D2	ElecEng	0	10.48	115	115	0.40	ELEC10	0.639	834.02
Memphis State University	3509	Pub	D1	ElecEng	0	5.90	63	63	0.43	ELEC10	0.639	834.02
Montana State University	2532	Pub	D2	ElecEng	0	8.26	317	317	0.43	ELEC10	0.639	834.02
Tennessee Technological University	3523	Pub	D2	ElecEng	0	9.43	74	74	0.43	ELEC10	0.639	834.02
University of Toledo	3131	Pub	D1	ElecEng	0	14.08	86	86	0.44	ELEC10	0.639	834.02
University of Louisville	1999	Pub	D1	ElecEng	0	10.76	88	88	0.44	ELEC10	0.639	834.02
University of Idaho	1626	Pub	D2	ElecEng	0	12.41	23	23	0.44	ELEC10	0.639	834.02
University of Wisconsin-Milwaukee	3896	Pub	D1	ElecEng	0	9.16	121	121	0.46	ELEC10	0.639	834.02
Texas Tech University	3644	Pub	D1	ElecEng	21	21.00	1,026	1,026	0.54	ELEC10	0.639	834.02
Mississippi State University	2423	Pub	R2	ElecEng	19	19.00	237	237	0.55	ELEC10	0.639	834.02
University of Alabama	1051	Pub	D1	ElecEng	0	12.41	176	176	0.58	ELEC10	0.639	834.02
University of Hawaii at Manoa	1610	Pub	R1	ElecEng	17	17.00	376	376	0.58	ELEC10	0.639	834.02
University of Mississippi, Main Campus	2440	Pub	D1	ElecEng	0	10.31	62	62	0.59	ELEC10	0.639	834.02
University of Colorado at Boulder	1370	Pub	R1	ElecEng	51	51.00	1,065	1,065	0.59	ELEC10	0.639	834.02
North Dakota State University, All Campuses	9265	Pub	D2	ElecEng	0	7.93	8	8	0.63	ELEC10	0.639	834.02
University of Maine at Orono	2053	Pub	D2	ElecEng	0	8.55	218	218	0.64	ELEC10	0.639	834.02
Washington State University	3800	Pub	R2	ElecEng	0	18.74	625	625	0.66	ELEC10	0.639	834.02
University of Kentucky, Main Campus	1989	Pub	R1	ElecEng	0	20.37	989	989	0.67	ELEC10	0.639	834.02
Utah State University	3677	Pub	R2	ElecEng	14	14.00	125	125	0.67	ELEC10	0.639	834.02
University of North Dakota, All Campuses	3005	Pub	D2	ElecEng	0	6.60	310	310	0.68	ELEC10	0.639	834.02
University of Akron, All Campuses	3123	Pub	D1	ElecEng	0	9.74	24	24	0.68	ELEC10	0.639	834.02
University of New Hampshire, Main Campus	2589	Pub	D2	ElecEng	0	11.84	129	129	0.74	ELEC10	0.639	834.02
Old Dominion University	3728	Pub	D2	ElecEng	0	12.37	302	302	0.76	ELEC10	0.639	834.02
University of South Carolina at Columbia	3448	Pub	R2	ElecEng	0	16.21	116	116	0.76	ELEC10	0.639	834.02
University of Nevada-Reno	2568	Pub	D2	ElecEng	0	6.15	30	30	0.79	ELEC10	0.639	834.02
Louisiana Tech University	2008	Pub	D2	ElecEng	0	11.08	0	11	0.84	ELEC10	0.639	834.02
Northern Illinois University	1737	Pub	D1	ElecEng	0	0.97	0	1	0.86	ELEC10	0.639	834.02
University of New Orleans	2015	Pub	D2	ElecEng	0	8.11	0	8	0.90	ELEC10	0.639	834.02
Temple University	3371	Pub	R2	ElecEng	0	14.25	0	14	0.95	ELEC10	0.639	834.02
University of California-Irvine	1314	Pub	R1	ElecEng	13	13.00	0	14	0.96	ELEC10	0.639	834.02
Northern Arizona University	1082	Pub	D2	ElecEng	0	4.40	46	46	0.96	ELEC10	0.639	834.02
Western Michigan University	2330	Pub	D1	ElecEng	0	11.08	2	2	0.98	ELEC10	0.639	834.02
Portland State University	3216	Pub	D2	ElecEng	0	8.11	9	9	0.99	ELEC10	0.639	834.02
Indiana University at Bloomington	1809	Pub	R1	ElecEng	0	48.96	1	1	1.10	ELEC10	0.639	834.02
University of South Florida	1537	Pub	D1	ElecEng	0	17.02	255	255	1.16	ELEC10	0.639	834.02
University of Alabama at Birmingham	1052	Pub	D2	ElecEng	0	3.61	40	40	1.21	ELEC10	0.639	834.02
Southern Illinois University-Carbondale	1758	Pub	R2	ElecEng	0	12.90	32	32	1.21	ELEC10	0.639	834.02
Kent State University, All Campuses	3051	Pub	D1	ElecEng	0	5.17	0	5	1.23	ELEC10	0.639	834.02
Colorado School of Mines	1348	Pub	D2	ElecEng	0	3.61	0	4	1.23	ELEC10	0.639	834.02
Miami University, All Campuses	7104	Pub	D1	ElecEng	0	3.61	3	3	1.23	ELEC10	0.639	834.02
Middle Tennesse State University	3510	Pub	D2	ElecEng	0	1.90	0	2	1.23	ELEC10	0.639	834.02

Table 5-A.10: Segmentation Array: Electrical Engineering

School	FICE	TOC	Carnegie Class	Academic Discipline	Faculty	Faculty (adjusted)	R&D Expenditures	R&D Exp (adjusted)	Factor Score	Segment	Segment RU Fraction	Segment Faculty
Idaho State University	1620	Pub	D2	ElecEng	0	0.97	0	1	1.23	ELEC10	0.639	834.02
Ball State University	1786	Pub	D1	ElecEng	0	•	0	•	•	ELEC10	0.639	834.02
Bowling Green State University, All Campuses	3018	Pub	D1	ElecEng	0	•	0	•	•	ELEC10	0.639	834.02
College of William and Mary	3705	Pub	D1	ElecEng	0	•	0	•	•	ELEC10	0.639	834.02
CUNY Graduate School and University Center	4063	Pub	D1	ElecEng	14	14.00	0	•	•	ELEC10	0.639	834.02
East Texas State University, All Campuses	3565	Pub	D2	ElecEng	0	•	0	•	•	ELEC10	0.639	834.02
Florida State University	1469	Pub	R2	ElecEng	0	•	0	•	•	ELEC10	0.639	834.02
Georgia State University	1574	Pub	D1	ElecEng	0	•	0	•	•	ELEC10	0.639	834.02
Illinois State University	1692	Pub	D2	ElecEng	0	•	0	•	•	ELEC10	0.639	834.02
Indiana State University, Terre Haute	9563	Pub	D2	ElecEng	0	•	0	•	•	ELEC10	0.639	834.02
Louisiana State University and Agric & Mech Cc	2010	Pub	R1	ElecEng	0	•	0	•	•	ELEC10	0.639	834.02
SUNY at Albany	2835	Pub	R2	ElecEng	0	•	0	•	•	ELEC10	0.639	834.02
SUNY at Binghamton	2836	Pub	D1	ElecEng	0	•	0	•	•	ELEC10	0.639	834.02
SUNY College of Environmental Science and F	2851	Pub	D2	ElecEng	0	•	0	•	•	ELEC10	0.639	834.02
Texas Woman's University	3646	Pub	D1	ElecEng	0	•	0	•	•	ELEC10	0.639	834.02
University of California-Riverside	1316	Pub	D1	ElecEng	0	•	0	•	•	ELEC10	0.639	834.02
University of California-San Diego	1317	Pub	R1	ElecEng	20	20.00	0	•	•	ELEC10	0.639	834.02
University of California-San Francisco	1319	Pub	R1	ElecEng	0	•	0	•	•	ELEC10	0.639	834.02
University of California-Santa Cruz	1321	Pub	D1	ElecEng	0	•	0	•	•	ELEC10	0.639	834.02
University of Georgia	1598	Pub	R1	ElecEng	0	•	0	•	•	ELEC10	0.639	834.02
University of Maryland Baltimore County	2105	Pub	D2	ElecEng	0	•	0	•	•	ELEC10	0.639	834.02
University of Missouri, Kansas City	2518	Pub	D2	ElecEng	0	•	0	•	•	ELEC10	0.639	834.02
University of Missouri, Saint Louis	2519	Pub	D2	ElecEng	0	•	0	•	•	ELEC10	0.639	834.02
University of Montana	2536	Pub	D1	ElecEng	0	•	0	•	•	ELEC10	0.639	834.02
University of North Carolina at Chapel Hill	2974	Pub	R1	ElecEng	0	•	0	•	•	ELEC10	0.639	834.02
University of North Carolina at Greensboro	2976	Pub	D2	ElecEng	0	•	0	•	•	ELEC10	0.639	834.02
University of North Texas	3594	Pub	D1	ElecEng	0	•	0	•	•	ELEC10	0.639	834.02
University of Northern Colorado	1349	Pub	D1	ElecEng	0	•	0	•	•	ELEC10	0.639	834.02
University of Oregon	3223	Pub	R2	ElecEng	0	•	0	•	•	ELEC10	0.639	834.02
University of South Dakota	3474	Pub	D2	ElecEng	0	•	0	•	•	ELEC10	0.639	834.02
University of Southern Mississippi	2441	Pub	D1	ElecEng	0	•	0	•	•	ELEC10	0.639	834.02
University of Texas at Dallas	9741	Pub	D2	ElecEng	0	•	0	•	•	ELEC10	0.639	834.02
Virginia Commonwealth University	3735	Pub	R2	ElecEng	0	•	0	•	•	ELEC10	0.639	834.02

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Table 5-A.11: Segmentation Array: Mechanical Engineering

School	FICE	TOC	Carnegie Class	Academic Discipline	Faculty	Faculty (adjusted)	R&D Expenditures	R&D Exp (adjusted)	Factor Score	Segment	Segment RU Fraction	Segment Faculty
Columbia University, Main Campus	2707	Pri	R1	MechEng	7	7.00	1,858	1,858	-3.68	MECH01	0.840	156.00
University of Miami	1536	Pri	R1	MechEng	5	5.00	583	583	-3.24	MECH01	0.840	156.00
Catholic University of America	1437	Pri	D1	MechEng	7	7.00	313	313	-2.52	MECH01	0.840	156.00
Stanford University	1305	Pri	R1	MechEng	36	36.00	4,099	4,099	-2.36	MECH01	0.840	156.00
Johns Hopkins University	2077	Pri	R1	MechEng	3	3.00	337	337	-2.34	MECH01	0.840	156.00
California Institute of Technology	1131	Pri	R1	MechEng	11	11.00	1,909	1,909	-1.96	MECH01	0.840	156.00
Massachusetts Institute of Technology	2178	Pri	R1	MechEng	53	53.00	8,683	8,683	-1.76	MECH01	0.840	156.00
Drexel University	3256	Pri	D2	MechEng	18	18.00	1,359	1,359	-0.92	MECH01	0.840	156.00
University of Rochester	2894	Pri	R1	MechEng	16	16.00	15,193	15,193	-0.78	MECH01	0.840	156.00
Illinois Institute of Technology	1691	Pri	D1	MechEng	14	14.00	868	868	-0.78	MECH02	0.572	549.55
University of Pennsylvania	3378	Pri	R1	MechEng	12	12.00	394	394	-0.75	MECH02	0.572	549.55
Washington University	2520	Pri	R1	MechEng	12	12.00	674	674	-0.66	MECH02	0.572	549.55
Cornell University, All Campuses	2711	Pri	R1	MechEng	24	24.00	697	697	-0.65	MECH02	0.572	549.55
Carnegie Mellon University	3242	Pri	R1	MechEng	14	14.00	747	747	-0.54	MECH02	0.572	549.55
University of Notre Dame	1840	Pri	D1	MechEng	11	11.00	0	20	-0.43	MECH02	0.572	549.55
Case Western Reserve University	3024	Pri	R1	MechEng	16	16.00	1,324	1,324	-0.39	MECH02	0.572	549.55
Duke University	2920	Pri	R1	MechEng	0	13.14	326	326	-0.35	MECH02	0.572	549.55
Rice University	3604	Pri	D1	MechEng	14	14.00	216	216	-0.35	MECH02	0.572	549.55
Brigham Young University, Main Campus	3670	Pri	D1	MechEng	0	7.83	408	408	-0.34	MECH02	0.572	549.55
Polytechnic University	2796	Pri	D2	MechEng	15	15.00	1,287	1,287	-0.33	MECH02	0.572	549.55
University of Southern California	1328	Pri	R1	MechEng	10	10.00	166	166	-0.28	MECH02	0.572	549.55
Princeton University	2627	Pri	R1	MechEng	26	26.00	0	19	-0.10	MECH02	0.572	549.55
Clarkson University	2699	Pri	D2	MechEng	0	14.55	184	184	-0.09	MECH02	0.572	549.55
Rensselaer Polytechnic Institute	2803	Pri	R2	MechEng	39	39.00	2,063	2,063	-0.09	MECH02	0.572	549.55
Brown University	3401	Pri	R2	MechEng	21	21.00	805	805	-0.06	MECH02	0.572	549.55
Northeastern University	2199	Pri	D2	MechEng	0	17.54	241	241	-0.05	MECH02	0.572	549.55
Stevens Institute of Technology	2639	Pri	D2	MechEng	16	16.00	102	102	-0.01	MECH02	0.572	549.55
George Washington University	1444	Pri	R2	MechEng	0	24.48	641	641	0.02	MECH02	0.572	549.55
Vanderbilt University	3535	Pri	R1	MechEng	10	10.00	137	137	0.06	MECH02	0.572	549.55
Northwestern University	1739	Pri	R1	MechEng	25	25.00	1,053	1,053	0.08	MECH02	0.572	549.55
Syracuse University, Main Campus	2882	Pri	R2	MechEng	7	7.00	972	972	0.18	MECH02	0.572	549.55
Marquette University	3863	Pri	D1	MechEng	0	10.17	63	63	0.23	MECH02	0.572	549.55
Southern Methodist University	3613	Pri	D2	MechEng	0	11.53	160	160	0.33	MECH02	0.572	549.55
Tufts University	2219	Pri	D1	MechEng	0	11.73	120	120	0.43	MECH02	0.572	549.55
Lehigh University	3289	Pri	D1	MechEng	29	29.00	780	780	0.44	MECH02	0.572	549.55
Tulane University of Louisiana	2029	Pri	R2	MechEng	6	6.00	148	148	0.44	MECH02	0.572	549.55
Harvard University	2155	Pri	R1	MechEng	8	8.00	613	613	0.71	MECH02	0.572	549.55
University of Tulsa	3185	Pri	D2	MechEng	0	9.35	206	206	0.79	MECH02	0.572	549.55
Florida Institute of Technology	1469	Pri	D2	MechEng	0	11.86	35	35	0.80	MECH02	0.572	549.55
Howard University	1448	Pri	R1	MechEng	0	12.36	284	284	0.87	MECH02	0.572	549.55
University of Denver	1371	Pri	D1	MechEng	0	10.59	1,488	1,488	1.06	MECH02	0.572	549.55
Yale University	1426	Pri	R1	MechEng	9	9.00	498	498	1.13	MECH02	0.572	549.55
Hofstra University	2732	Pri	D2	MechEng	0	5.58	0	6	1.13	MECH02	0.572	549.55
Dartmouth College	2573	Pri	D2	MechEng	0	9.35	246	246	1.15	MECH02	0.572	549.55

Table 5-A.11: Segmentation Array: Mechanical Engineering

School	FICE	TOC	Carnegie Class	Academic Discipline	Faculty	Faculty (adjusted)	R&D Expenditures	R&D Exp (adjusted)	Factor Score	Segment	Segment RU Fraction	Segment Faculty
Loma Linda University	1218	Pri	D2	MechEng	0	11.52	0	12	1.17	MECH02	0.572	549.55
Emory University	1564	Pri	R2	MechEng	0	14.04	0	14	1.19	MECH02	0.572	549.55
Saint Louis University, Main Campus	2506	Pri	D1	MechEng	0	2.76	8	8	1.22	MECH02	0.572	549.55
Brandeis University	2133	Pri	R2	MechEng	0	5.12	0	5	1.22	MECH02	0.572	549.55
University of Chicago	1774	Pri	R1	MechEng	0	5.12	0	5	1.22	MECH02	0.572	549.55
Andrews University	2238	Pri	D2	MechEng	0	0.97	0	1	1.22	MECH02	0.572	549.55
University of San Francisco	1325	Pri	D2	MechEng	0	0.97	0	1	1.22	MECH02	0.572	549.55
Yeshiva University	2903	Pri	R1	MechEng	0	0.97	0	1	1.22	MECH02	0.572	549.55
Adelphi University	2666	Pri	D2	MechEng	0 •		0 •		•	MECH02	0.572	549.55
American University	1434	Pri	D1	MechEng	0 •		0 •		•	MECH02	0.572	549.55
Baylor University	6967	Pri	D2	MechEng	0 •		0 •		•	MECH02	0.572	549.55
Biola University	1122	Pri	D2	MechEng	0 •		0 •		•	MECH02	0.572	549.55
Boston College	2128	Pri	D1	MechEng	0 •		0 •		•	MECH02	0.572	549.55
Boston University	2130	Pri	R1	MechEng	0 •		0 •		•	MECH02	0.572	549.55
Claremont Univ Center & Graduate School	1169	Pri	D1	MechEng	0 •		0 •		•	MECH02	0.572	549.55
Clark Atlanta University	1559	Pri	D2	MechEng	0 •		0 •		•	MECH02	0.572	549.55
Clark University	2139	Pri	D2	MechEng	0 •		0 •		•	MECH02	0.572	549.55
Columbia University, Teachers College	3979	Pri	D1	MechEng	0 •		0 •		•	MECH02	0.572	549.55
Drake University	1860	Pri	D2	MechEng	0 •		0 •		•	MECH02	0.572	549.55
Duquesne University	3258	Pri	D2	MechEng	0 •		0 •		•	MECH02	0.572	549.55
Fordham University	2722	Pri	D1	MechEng	0 •		0 •		•	MECH02	0.572	549.55
Georgetown University	1445	Pri	R2	MechEng	0 •		0 •		•	MECH02	0.572	549.55
Hahnemann University	3271	Pri	D2	MechEng	0 •		0 •		•	MECH02	0.572	549.55
Loyola University of Chicago	1710	Pri	D1	MechEng	0 •		0 •		•	MECH02	0.572	549.55
New School For Social Research	2780	Pri	D2	MechEng	0 •		0 •		•	MECH02	0.572	549.55
New York University	2785	Pri	R1	MechEng	0 •		0 •		•	MECH02	0.572	549.55
Nova University	1509	Pri	D1	MechEng	0 •		0 •		•	MECH02	0.572	549.55
Pepperdine University	1264	Pri	D2	MechEng	0 •		0 •		•	MECH02	0.572	549.55
Rockefeller University	2807	Pri	R1	MechEng	0 •		0 •		•	MECH02	0.572	549.55
Saint John's University New York	2823	Pri	D1	MechEng	0 •		0 •		•	MECH02	0.572	549.55
Texas Christian University	3636	Pri	D2	MechEng	0 •		0 •		•	MECH02	0.572	549.55
Union Institute	10923	Pri	D1	MechEng	0 •		0 •		•	MECH02	0.572	549.55
University of California-Berkeley	1312	Pub	R1	MechEng	45	45.00	2,046	2,046	-2.83	MECH03	1.000	101.00
Georgia Institute of Technology, Main Campus	1569	Pub	R1	MechEng	16	16.00	4,441	4,441	-2.56	MECH03	1.000	101.00
University of Minnesota at Twin Cities	3969	Pub	R1	MechEng	24	24.00	2,010	2,010	-2.13	MECH03	1.000	101.00
Iowa State University	1869	Pub	R2	MechEng	18	18.00	1,830	1,830	-1.88	MECH03	1.000	101.00
Oklahoma State University, All Campuses	3170	Pub	R2	MechEng	17	17.00	839	839	-1.62	MECH04	1.000	120.00
University of Illinois at Urbana-Champaign	1775	Pub	R1	MechEng	43	43.00	1,109	1,109	-1.57	MECH04	1.000	120.00
University of Wisconsin-Madison	3895	Pub	R1	MechEng	32	32.00	1,508	1,508	-1.39	MECH04	1.000	120.00
Virginia Polytechnic Institute and State Univ	3754	Pub	R1	MechEng	28	28.00	2,708	2,708	-1.36	MECH04	1.000	120.00
University of Pittsburgh Main Campus	3379	Pub	R1	MechEng	10	10.00	542	542	-1.34	MECH05	0.863	175.00
Rutgers, the State University at New Brunswick	6964	Pub	R1	MechEng	14	14.00	327	327	-1.28	MECH05	0.863	175.00
Michigan State University	2290	Pub	R1	MechEng	18	18.00	1,125	1,125	-1.24	MECH05	0.863	175.00
University of Florida	1535	Pub	R1	MechEng	15	15.00	2,219	2,219	-1.19	MECH05	0.863	175.00

Table 5-A.11: Segmentation Array: Mechanical Engineering

School	FICE	TOC	Carnegie Class	Academic Discipline	Faculty	Faculty (adjusted)	R&D Expenditures	R&D Exp (adjusted)	Factor Score	Segment	Segment RU Fraction	Segment Faculty
University of Arizona	1083	Pub	R1	MechEng	9	9.00	0	18	-1.16	MECH05	0.863	175.00
Purdue University, Main Campus	1825	Pub	R1	MechEng	45	45.00	2,727	2,727	-1.13	MECH05	0.863	175.00
University of Cincinnati, All Campuses	3125	Pub	R1	MechEng	16	16.00	352	352	-0.92	MECH05	0.863	175.00
University of Houston-University Park	3652	Pub	D1	MechEng	24	24.00	549	549	-0.91	MECH05	0.863	175.00
University of Missouri, Columbia	2516	Pub	R1	MechEng	8	8.00	50	50	-0.87	MECH05	0.863	175.00
University of Connecticut, Main Campus	29013	Pub	R1	MechEng	16	16.00	670	670	-0.75	MECH05	0.863	175.00
University of Texas at Austin	3658	Pub	R1	MechEng	35	35.00	716	716	-0.73	MECH06	0.826	369.61
Ohio State University, Main Campus	6883	Pub	R1	MechEng	23	23.00	1,017	1,017	-0.64	MECH06	0.826	369.61
SUNY at Stony Brook, All Campuses	2838	Pub	R1	MechEng	15	15.00	929	929	-0.50	MECH06	0.826	369.61
University of Alabama	1051	Pub	D1	MechEng	9	9.00	145	145	-0.50	MECH06	0.826	369.61
Tennessee Technological University	3523	Pub	D2	MechEng	0	10.65	94	94	-0.46	MECH06	0.826	369.61
SUNY at Buffalo, Main Campus	2837	Pub	R2	MechEng	21	21.00	499	499	-0.44	MECH06	0.826	369.61
University of California-Santa Barbara	1320	Pub	R2	MechEng	0	14.78	273	273	-0.36	MECH06	0.826	369.61
Wayne State University	2329	Pub	R2	MechEng	15	15.00	530	530	-0.34	MECH06	0.826	369.61
Oregon State University	3210	Pub	R1	MechEng	14	14.00	375	375	-0.19	MECH06	0.826	369.61
University of New Mexico, All Campuses	10313	Pub	R1	MechEng	10	10.00	111	111	-0.19	MECH06	0.826	369.61
University of California-Davis	1313	Pub	R1	MechEng	19	19.00	1,070	1,070	-0.18	MECH06	0.826	369.61
University of Missouri, Rolla	2517	Pub	D2	MechEng	22	22.00	632	632	-0.11	MECH06	0.826	369.61
New Mexico State University, All Campuses	2657	Pub	R1	MechEng	0	12.69	3,087	3,087	-0.11	MECH06	0.826	369.61
West Virginia University	3827	Pub	R2	MechEng	0	12.22	87	87	-0.10	MECH06	0.826	369.61
North Carolina State University at Raleigh	2972	Pub	R1	MechEng	27	27.00	1,214	1,214	-0.08	MECH06	0.826	369.61
University of Delaware	1431	Pub	R2	MechEng	15	15.00	732	732	-0.04	MECH06	0.826	369.61
University of Iowa	1892	Pub	R1	MechEng	24	24.00	448	448	-0.04	MECH06	0.826	369.61
University of Louisville	1999	Pub	D1	MechEng	0	6.53	72	72	-0.03	MECH06	0.826	369.61
Pennsylvania State U, Main Campus	6965	Pub	R1	MechEng	23	23.00	1,063	1,063	-0.03	MECH06	0.826	369.61
University of Kentucky, Main Campus	1989	Pub	R1	MechEng	13	13.00	797	797	-0.01	MECH06	0.826	369.61
University of Idaho	1626	Pub	D2	MechEng	0	7.20	45	45	0.05	MECH06	0.826	369.61
University of Toledo	3131	Pub	D1	MechEng	0	8.81	112	112	0.10	MECH06	0.826	369.61
Mississippi State University	2423	Pub	R2	MechEng	0	11.73	184	184	0.12	MECH06	0.826	369.61
University of Michigan at Ann Arbor	9092	Pub	R1	MechEng	57	57.00	5,114	5,114	0.13	MECH07	0.671	819.93
Texas A & M University, Main Campus	10366	Pub	R1	MechEng	34	34.00	989	989	0.13	MECH07	0.671	819.93
University of New Hampshire, Main Campus	2589	Pub	D2	MechEng	0	11.53	461	461	0.13	MECH07	0.671	819.93
Washington State University	3800	Pub	R2	MechEng	0	16.38	500	500	0.16	MECH07	0.671	819.93
Kansas State University of Agriculture and App	1928	Pub	R2	MechEng	13	13.00	143	143	0.17	MECH07	0.671	819.93
University of Maryland at College Park	2103	Pub	R1	MechEng	27	27.00	578	578	0.17	MECH07	0.671	819.93
University of Massachusetts at Amherst	2221	Pub	R2	MechEng	21	21.00	571	571	0.17	MECH07	0.671	819.93
Auburn University, Main Campus	1009	Pub	R2	MechEng	19	19.00	239	239	0.29	MECH07	0.671	819.93
Old Dominion University	3728	Pub	D2	MechEng	16	16.00	533	533	0.29	MECH07	0.671	819.93
Clemson University	3,425	Pub	D1	MechEng	0	15.29	434	434	0.29	MECH07	0.671	819.93
University of California-Los Angeles	1315	Pub	R1	MechEng	34	34.00	452	452	0.31	MECH07	0.671	819.93
Cleveland State University	3032	Pub	D2	MechEng	0	9.53	129	129	0.31	MECH07	0.671	819.93
University of Colorado at Boulder	1370	Pub	R1	MechEng	0	17.83	318	318	0.32	MECH07	0.671	819.93
University of Utah	3675	Pub	R1	MechEng	0	24.04	1,188	1,188	0.33	MECH07	0.671	819.93
University of Akron, All Campuses	3123	Pub	D1	MechEng	11	11.00	107	107	0.33	MECH07	0.671	819.93

Table 5-A.11: Segmentation Array: Mechanical Engineering

School	FICE	TOC	Carnegie Class	Academic Discipline	Faculty	Faculty (adjusted)	R&D Expenditures	R&D Exp (adjusted)	Factor Score	Segment	Segment RU Fraction	Segment Faculty
University of Vermont	3696	Pub	D2	MechEng	0	10.02	31	31	0.34	MECH07	0.671	819.93
Texas Tech University	3644	Pub	D1	MechEng	0	13.30	806	806	0.35	MECH07	0.671	819.93
Arizona State University	1081	Pub	R2	MechEng	19	19.00	491	491	0.35	MECH07	0.671	819.93
University of Washington	3798	Pub	R1	MechEng	33	33.00	339	339	0.39	MECH07	0.671	819.93
Montana State University	2532	Pub	D2	MechEng	0	6.82	651	651	0.40	MECH07	0.671	819.93
Colorado State University	1350	Pub	R1	MechEng	16	16.00	1,534	1,534	0.42	MECH07	0.671	819.93
University of Hawaii at Manoa	1610	Pub	R1	MechEng	0	9.04	385	385	0.44	MECH07	0.671	819.93
University of South Carolina at Columbia	3448	Pub	R2	MechEng	0	12.09	90	90	0.45	MECH07	0.671	819.93
University of Illinois at Chicago	1776	Pub	R1	MechEng	27	27.00	275	275	0.50	MECH07	0.671	819.93
University of Texas at Arlington	3656	Pub	D2	MechEng	0	16.47	167	167	0.51	MECH07	0.671	819.93
University of Virginia, Main Campus	6968	Pub	R1	MechEng	24	24.00	729	729	0.52	MECH07	0.671	819.93
University of Kansas, Main Campus	1948	Pub	R2	MechEng	0	16.16	299	299	0.54	MECH07	0.671	819.93
University of Nebraska at Lincoln	2565	Pub	R2	MechEng	0	16.45	133	133	0.57	MECH07	0.671	819.93
University of Arkansas, Main Campus	1108	Pub	D1	MechEng	0	14.13	1,281	1,281	0.57	MECH07	0.671	819.93
Memphis State University	3509	Pub	D1	MechEng	0	10.02	52	52	0.65	MECH07	0.671	819.93
Ohio University, All Campuses	3100	Pub	D1	MechEng	0	3.58	61	61	0.69	MECH07	0.671	819.93
Utah State University	3677	Pub	R2	MechEng	0	7.83	137	137	0.69	MECH07	0.671	819.93
Louisiana Tech University	2008	Pub	D2	MechEng	0	7.83	68	68	0.71	MECH07	0.671	819.93
University of Maine at Orono	2053	Pub	D2	MechEng	0	7.20	214	214	0.73	MECH07	0.671	819.93
University of Oklahoma, Norman Campus	3184	Pub	R2	MechEng	18	18.00	372	372	0.75	MECH07	0.671	819.93
University of Rhode Island	3414	Pub	R2	MechEng	16	16.00	398	398	0.75	MECH07	0.671	819.93
University of Wyoming	3932	Pub	R2	MechEng	0	9.43	130	130	0.77	MECH07	0.671	819.93
University of Mississippi, Main Campus	2440	Pub	D1	MechEng	0	6.18	53	53	0.78	MECH07	0.671	819.93
Florida Atlantic University	1481	Pub	D2	MechEng	0	4.56	22	22	0.82	MECH07	0.671	819.93
Western Michigan University	2330	Pub	D1	MechEng	0	14.04	3	3	0.83	MECH07	0.671	819.93
North Dakota State University, All Campuses	9265	Pub	D2	MechEng	0	8.81	10	10	0.83	MECH07	0.671	819.93
University of Wisconsin-Milwaukee	3896	Pub	D1	MechEng	0	11.06	163	163	0.87	MECH07	0.671	819.93
University of New Orleans	2015	Pub	D2	MechEng	0	9.35	6	6	0.87	MECH07	0.671	819.93
University of Nevada-Reno	2568	Pub	D2	MechEng	0	5.84	0	6	0.89	MECH07	0.671	819.93
Temple University	3371	Pub	R2	MechEng	0	16.75	1	1	0.89	MECH07	0.671	819.93
University of California-Irvine	1314	Pub	R1	MechEng	0	3.69	0	4	0.91	MECH07	0.671	819.93
University of North Dakota, All Campuses	3005	Pub	D2	MechEng	0	9.61	234	234	0.95	MECH07	0.671	819.93
Northern Arizona University	1082	Pub	D2	MechEng	0	5.84	0	6	0.98	MECH07	0.671	819.93
Portland State University	3216	Pub	D2	MechEng	0	7.19	6	6	1.09	MECH07	0.671	819.93
Southern Illinois University-Carbondale	1758	Pub	R2	MechEng	0	8.45	27	27	1.20	MECH07	0.671	819.93
Colorado School of Mines	1348	Pub	D2	MechEng	0	7.20	0	7	1.22	MECH07	0.671	819.93
University of South Florida	1537	Pub	D1	MechEng	0	7.83	3	3	1.22	MECH07	0.671	819.93
Kent State University, All Campuses	3051	Pub	D1	MechEng	0	5.84	0	6	1.22	MECH07	0.671	819.93
University of Alabama at Birmingham	1052	Pub	D2	MechEng	0	5.12	0	5	1.22	MECH07	0.671	819.93
Miami University, All Campuses	7104	Pub	D1	MechEng	0	2.76	3	3	1.22	MECH07	0.671	819.93
Middle Tennesse State University	3510	Pub	D2	MechEng	0	1.89	0	2	1.22	MECH07	0.671	819.93
Idaho State University	1620	Pub	D2	MechEng	0	0.97	0	1	1.22	MECH07	0.671	819.93
Northern Illinois University	1737	Pub	D1	MechEng	0	0.97	0	1	1.22	MECH07	0.671	819.93
Ball State University	1786	Pub	D1	MechEng	0 •		0 •		•	MECH07	0.671	819.93

Table 5-A.11: Segmentation Array: Mechanical Engineering

School	FICE	TOC	Carnegie Class	Academic Discipline	Faculty	Faculty (adjusted)	R&D Expenditures	R&D Exp (adjusted)	Factor Score	Segment	Segment RU Fraction	Segment Faculty
Bowling Green State University, All Campuses	3018	Pub	D1	MechEng	0		0			MECH07	0.671	819.93
College of William and Mary	3705	Pub	D1	MechEng	0		0			MECH07	0.671	819.93
CUNY Graduate School and University Center	4063	Pub	D1	MechEng	0		0			MECH07	0.671	819.93
East Texas State University, All Campuses	3565	Pub	D2	MechEng	0		0			MECH07	0.671	819.93
Florida State University	1489	Pub	R2	MechEng	0		0			MECH07	0.671	819.93
Georgia State University	1574	Pub	D1	MechEng	0		0			MECH07	0.671	819.93
Illinois State University	1692	Pub	D2	MechEng	0		0			MECH07	0.671	819.93
Indiana State University, Terre Haute	9563	Pub	D2	MechEng	0		0			MECH07	0.671	819.93
Indiana University at Bloomington	1809	Pub	R1	MechEng	0		0			MECH07	0.671	819.93
Louisiana State University and Agric & Mech Co	2010	Pub	R1	MechEng	0		0			MECH07	0.671	819.93
SUNY at Albany	2835	Pub	R2	MechEng	0		0			MECH07	0.671	819.93
SUNY at Binghamton	2836	Pub	D1	MechEng	0		0			MECH07	0.671	819.93
SUNY College of Environmental Science and F	2851	Pub	D2	MechEng	0		0			MECH07	0.671	819.93
Texas Woman's University	3646	Pub	D1	MechEng	0		0			MECH07	0.671	819.93
University of California-Riverside	1316	Pub	D1	MechEng	0		0			MECH07	0.671	819.93
University of California-San Diego	1317	Pub	R1	MechEng	0		1,997	1,997		MECH07	0.671	819.93
University of California-San Francisco	1319	Pub	R1	MechEng	0		0			MECH07	0.671	819.93
University of California-Santa Cruz	1321	Pub	D1	MechEng	0		0			MECH07	0.671	819.93
University of Georgia	1598	Pub	R1	MechEng	0		0			MECH07	0.671	819.93
University of Maryland Baltimore County	2105	Pub	D2	MechEng	0		0			MECH07	0.671	819.93
University of Missouri, Kansas City	2518	Pub	D2	MechEng	0		0			MECH07	0.671	819.93
University of Missouri, Saint Louis	2519	Pub	D2	MechEng	0		0			MECH07	0.671	819.93
University of Montana	2536	Pub	D1	MechEng	0		0			MECH07	0.671	819.93
University of North Carolina at Chapel Hill	2974	Pub	R1	MechEng	0		0			MECH07	0.671	819.93
University of North Carolina at Greensboro	2976	Pub	D2	MechEng	0		0			MECH07	0.671	819.93
University of North Texas	3594	Pub	D1	MechEng	0		0			MECH07	0.671	819.93
University of Northern Colorado	1349	Pub	D1	MechEng	0		0			MECH07	0.671	819.93
University of Oregon	3223	Pub	R2	MechEng	0		0			MECH07	0.671	819.93
University of South Dakota	3474	Pub	D2	MechEng	0		0			MECH07	0.671	819.93
University of Southern Mississippi	2441	Pub	D1	MechEng	0		0			MECH07	0.671	819.93
University of Tennessee at Knoxville	3530	Pub	R1	MechEng	32	32.00	0			MECH07	0.671	819.93
University of Texas at Dallas	9741	Pub	D2	MechEng	0		0			MECH07	0.671	819.93
Virginia Commonwealth University	3735	Pub	R2	MechEng	0		0			MECH07	0.671	819.93

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Table 5-A.12: Segmentation Array: Computer Science

School	FICE	TOC	Carnegie Class	Academic Discipline	Faculty	Faculty (adjusted)	R&D Expenditures	R&D Exp (adjusted)	Factor Score	Segment	Segment RU Fraction	Segment Faculty
University of Southern California	1328	Pri	R1	CompSci	10	10.00	10,904	10,904	-5.34	COMP01	0.899	79.00
California Institute of Technology	1131	Pri	R1	CompSci	5	5.00	1,906	1,906	-4.84	COMP01	0.899	79.00
Stanford University	1305	Pri	R1	CompSci	21	21.00	4,032	4,032	-4.07	COMP01	0.899	79.00
Polytechnic University	2796	Pri	D2	CompSci	8	8.00	0	14	-3.23	COMP01	0.899	79.00
Washington University	2520	Pri	R1	CompSci	8	8.00	3,336	3,336	-2.87	COMP01	0.899	79.00
Cornell University, All Campuses	2711	Pri	R1	CompSci	14	14.00	1,010	1,010	-1.90	COMP01	0.899	79.00
New York University	2785	Pri	R1	CompSci	13	13.00	1,227	1,227	-1.36	COMP01	0.899	79.00
University of Rochester	2894	Pri	R1	CompSci	11	11.00	603	603	-1.28	COMP02	0.624	595.64
Carnegie Mellon University	3242	Pri	R1	CompSci	31	31.00	5,263	5,263	-1.06	COMP02	0.624	595.64
Yale University	1426	Pri	R1	CompSci	16	16.00	1447	1447	-1.05	COMP02	0.624	595.64
Brown University	3401	Pri	R2	CompSci	8	8.00	600	600	-0.67	COMP02	0.624	595.64
University of Miami	1536	Pri	R1	CompSci	0	2.68	71	71	-0.61	COMP02	0.624	595.64
Princeton University	2627	Pri	R1	CompSci	9	9.00	348	348	-0.40	COMP02	0.624	595.64
Vanderbilt University	3535	Pri	R1	CompSci	9	9.00	57	57	-0.38	COMP02	0.624	595.64
Illinois Institute of Technology	1691	Pri	D1	CompSci	0	13.13	341	341	-0.36	COMP02	0.624	595.64
University of Pennsylvania	3378	Pri	R1	CompSci	29	29.00	2,529	2,529	-0.32	COMP02	0.624	595.64
Duke University	2920	Pri	R1	CompSci	13	13.00	270	270	-0.25	COMP02	0.624	595.64
Northwestern University	1739	Pri	R1	CompSci	24	24.00	0	12	-0.16	COMP02	0.624	595.64
George Washington University	1444	Pri	R2	CompSci	0	17.50	430	430	-0.14	COMP02	0.624	595.64
American University	1434	Pri	D1	CompSci	0	14.91	0	15	-0.02	COMP02	0.624	595.64
Harvard University	2155	Pri	R1	CompSci	0	9.45	889	889	-0.02	COMP02	0.624	595.64
Florida Institute of Technology	1469	Pri	D2	CompSci	0	10.02	0	10	-0.01	COMP02	0.624	595.64
Saint John's University New York	2823	Pri	D1	CompSci	0	1.86	0	2	0.03	COMP02	0.624	595.64
Southern Methodist University	3613	Pri	D2	CompSci	10	10.00	127	127	0.12	COMP02	0.624	595.64
Stevens Institute of Technology	2639	Pri	D2	CompSci	10	10.00	0	6	0.17	COMP02	0.624	595.64
Rensselaer Polytechnic Institute	2803	Pri	R2	CompSci	0	13.76	0	14	0.19	COMP02	0.624	595.64
Johns Hopkins University	2077	Pri	R1	CompSci	0	15.79	23	23	0.20	COMP02	0.624	595.64
Massachusetts Institute of Technology	2178	Pri	R1	CompSci	53	53.00	7,844	7,844	0.24	COMP02	0.624	595.64
Case Western Reserve University	3024	Pri	R1	CompSci	7	7.00	0	6	0.25	COMP02	0.624	595.64
Boston University	2130	Pri	R1	CompSci	0	12.25	0	12	0.25	COMP02	0.624	595.64
Lehigh University	3289	Pri	D1	CompSci	0	8.92	194	194	0.34	COMP02	0.624	595.64
Syracuse University, Main Campus	2882	Pri	R2	CompSci	44	44.00	806	806	0.38	COMP02	0.624	595.64
Brigham Young University, Main Campus	3670	Pri	D1	CompSci	0	25.19	0	25	0.39	COMP02	0.624	595.64
Rockefeller University	2807	Pri	R1	CompSci	0	3.51	505	505	0.45	COMP02	0.624	595.64
Baylor University	6967	Pri	D2	CompSci	0	2.71	0	3	0.47	COMP02	0.624	595.64
Columbia University, Main Campus	2707	Pri	R1	CompSci	11	11.00	66	66	0.49	COMP02	0.624	595.64
University of Denver	1371	Pri	D1	CompSci	0	13.36	0	13	0.55	COMP02	0.624	595.64
Brandeis University	2133	Pri	R2	CompSci	0	2.71	0	3	0.57	COMP02	0.624	595.64
Drexel University	3256	Pri	D2	CompSci	0	5.66	293	293	0.57	COMP02	0.624	595.64
Northeastern University	2199	Pri	D2	CompSci	0	5.66	0	6	0.60	COMP02	0.624	595.64
University of San Francisco	1325	Pri	D2	CompSci	0	5.08	23	23	0.61	COMP02	0.624	595.64
Hofstra University	2732	Pri	D2	CompSci	0	16.06	6	6	0.61	COMP02	0.624	595.64
Columbia University, Teachers College	3979	Pri	D1	CompSci	0	1.40	0	1	0.64	COMP02	0.624	595.64
Andrews University	2238	Pri	D2	CompSci	0	0.96	0	1	0.64	COMP02	0.624	595.64

Table 5-A.12: Segmentation Array: Computer Science

School	FICE	TOC	Carnegie Class	Academic Discipline	Faculty	Faculty (adjusted)	R&D Expenditures	R&D Exp (adjusted)	Factor Score	Segment	Segment RU Fraction	Segment Faculty
Nova University	1509	Pri	D1	CompSci	0	6.97	2	2	0.70	COMP02	0.624	595.64
Drake University	1860	Pri	D2	CompSci	0	3.51	0	4	0.70	COMP02	0.624	595.64
Texas Christian University	3636	Pri	D2	CompSci	0	9.45	0	9	0.72	COMP02	0.624	595.64
Yeshiva University	2903	Pri	R1	CompSci	0	4.98	0	5	0.74	COMP02	0.624	595.64
Duquesne University	3258	Pri	D2	CompSci	0	3.51	0	4	0.74	COMP02	0.624	595.64
Clarkson University	2699	Pri	D2	CompSci	0	4.98	0	5	0.76	COMP02	0.624	595.64
Pepperdine University	1264	Pri	D2	CompSci	0	4.98	0	5	0.76	COMP02	0.624	595.64
Tufts University	2219	Pri	D1	CompSci	0	4.98	0	5	0.76	COMP02	0.624	595.64
Emory University	1564	Pri	R2	CompSci	0	9.94	0	10	0.76	COMP02	0.624	595.64
Loma Linda University	1218	Pri	D2	CompSci	0	8.85	94	94	0.77	COMP02	0.624	595.64
Dartmouth College	2573	Pri	D2	CompSci	0	4.56	0	5	0.77	COMP02	0.624	595.64
Clark University	2139	Pri	D2	CompSci	0	1.86	0	2	0.78	COMP02	0.624	595.64
Georgetown University	1445	Pri	R2	CompSci	0	1.86	0	2	0.78	COMP02	0.624	595.64
Marquette University	3863	Pri	D1	CompSci	0	1.86	0	2	0.78	COMP02	0.624	595.64
University of Chicago	1774	Pri	R1	CompSci	0	7.70	0	8	0.78	COMP02	0.624	595.64
Tulane University of Louisiana	2029	Pri	R2	CompSci	0	4.32	0	4	0.78	COMP02	0.624	595.64
Biola University	1122	Pri	D2	CompSci	0	1.78	0	2	0.84	COMP02	0.624	595.64
Rice University	3604	Pri	D1	CompSci	22	22.00	214	214	0.88	COMP02	0.624	595.64
Adelphi University	2666	Pri	D2	CompSci	0	0.00	0 •		•	COMP02	0.624	595.64
Boston College	2128	Pri	D1	CompSci	0	0.00	0 •		•	COMP02	0.624	595.64
Catholic University of America	1437	Pri	D1	CompSci	0	0.00	0 •		•	COMP02	0.624	595.64
Claremont Univ Center & Graduate School	1169	Pri	D1	CompSci	0	0.00	0 •		•	COMP02	0.624	595.64
Clark Atlanta University	1559	Pri	D2	CompSci	0	0.00	128	128	•	COMP02	0.624	595.64
Fordham University	2722	Pri	D1	CompSci	0	0.00	0 •		•	COMP02	0.624	595.64
Hahnemann University	3271	Pri	D2	CompSci	0	0.00	0 •		•	COMP02	0.624	595.64
Howard University	1448	Pri	R1	CompSci	0	0.00	0 •		•	COMP02	0.624	595.64
Loyola University of Chicago	1710	Pri	D1	CompSci	0	0.00	0 •		•	COMP02	0.624	595.64
New School For Social Research	2780	Pri	D2	CompSci	0	0.00	0 •		•	COMP02	0.624	595.64
Saint Louis University, Main Campus	2506	Pri	D1	CompSci	0	0.00	0 •		•	COMP02	0.624	595.64
Union Institute	10923	Pri	D1	CompSci	0	0.00	0 •		•	COMP02	0.624	595.64
University of Notre Dame	1840	Pri	D1	CompSci	0	0.00	0 •		•	COMP02	0.624	595.64
University of Tulsa	3185	Pri	D2	CompSci	0	0.00	0 •		•	COMP02	0.624	595.64
CUNY Graduate School and University Center	4063	Pub	D1	CompSci	0	0.96	0	1	-2.59	COMP03	0.957	196.37
University of Arizona	1083	Pub	R1	CompSci	7	7.00	396	396	-2.46	COMP03	0.957	196.37
Georgia Institute of Technology, Main Campus	1569	Pub	R1	CompSci	11	11.00	3,776	3,776	-1.85	COMP03	0.957	196.37
University of Michigan at Ann Arbor	9092	Pub	R1	CompSci	10	10.00	1,033	1,033	-1.68	COMP03	0.957	196.37
University of Illinois at Urbana-Champaign	1775	Pub	R1	CompSci	30	30.00	4,358	4,358	-1.64	COMP03	0.957	196.37
Iowa State University	1869	Pub	R2	CompSci	15	15.00	910	910	-1.63	COMP03	0.957	196.37
Ohio State University, Main Campus	6883	Pub	R1	CompSci	21	21.00	684	684	-1.54	COMP03	0.957	196.37
University of Pittsburgh Main Campus	3379	Pub	R1	CompSci	12	12.00	605	605	-1.46	COMP03	0.957	196.37
University of Washington	3798	Pub	R1	CompSci	12	12.00	407	407	-1.46	COMP03	0.957	196.37
University of Wisconsin-Madison	3895	Pub	R1	CompSci	25	25.00	842	842	-1.43	COMP03	0.957	196.37
SUNY at Buffalo, Main Campus	2837	Pub	R2	CompSci	11	11.00	565	565	-1.33	COMP03	0.957	196.37
East Texas State University, All Campuses	3565	Pub	D2	CompSci	0	7.52	0	8	-1.31	COMP03	0.957	196.37

Table 5-A.12: Segmentation Array: Computer Science

School	FICE	TOC	Carnegie Class	Academic Discipline	Faculty	Faculty (adjusted)	R&D Expenditures	R&D Exp (adjusted)	Factor Score	Segment	Segment RU Fraction	Segment Faculty
University of Colorado at Boulder	1370	Pub	R1	CompSci	0	10.33	508	508	-1.05	COMP03	0.957	196.37
Purdue University, Main Campus	1825	Pub	R1	CompSci	0	23.55	1,140	1,140	-1.01	COMP03	0.957	196.37
University of Illinois at Chicago	1776	Pub	R1	CompSci	0	1.86	0	2	-0.94	COMP04	0.652	1247.62
University of Missouri, Rolla	2517	Pub	D2	CompSci	11	11.00	101	101	-0.89	COMP04	0.652	1247.62
University of Texas at Austin	3658	Pub	R1	CompSci	27	27.00	2,445	2,445	-0.87	COMP04	0.652	1247.62
University of Maryland at College Park	2103	Pub	R1	CompSci	28	28.00	4,696	4,696	-0.79	COMP04	0.652	1247.62
University of Massachusetts at Amherst	2221	Pub	R2	CompSci	16	16.00	536	536	-0.72	COMP04	0.652	1247.62
University of Utah	3675	Pub	R1	CompSci	13	13.00	920	920	-0.67	COMP04	0.652	1247.62
SUNY at Stony Brook, All Campuses	2838	Pub	R1	CompSci	16	16.00	256	256	-0.67	COMP04	0.652	1247.62
University of North Carolina at Chapel Hill	2974	Pub	R1	CompSci	8	8.00	390	390	-0.57	COMP04	0.652	1247.62
Pennsylvania State U, Main Campus	6965	Pub	R1	CompSci	16	16.00	4,085	4,085	-0.56	COMP04	0.652	1247.62
Indiana University at Bloomington	1809	Pub	R1	CompSci	15	15.00	136	136	-0.53	COMP04	0.652	1247.62
Michigan State University	2290	Pub	R1	CompSci	14	14.00	249	249	-0.51	COMP04	0.652	1247.62
Virginia Polytechnic Institute and State Univ	3754	Pub	R1	CompSci	0	10.16	202	202	-0.50	COMP04	0.652	1247.62
University of Delaware	1431	Pub	R2	CompSci	0	6.47	31	31	-0.47	COMP04	0.652	1247.62
University of North Texas	3594	Pub	D1	CompSci	0	7.12	6	6	-0.36	COMP04	0.652	1247.62
University of Minnesota at Twin Cities	3969	Pub	R1	CompSci	21	21.00	156	156	-0.35	COMP04	0.652	1247.62
Rutgers, the State University at New Brunswick	6964	Pub	R1	CompSci	29	29.00	1,885	1,885	-0.26	COMP04	0.652	1247.62
University of Connecticut, Main Campus	29013	Pub	R1	CompSci	11	11.00	493	493	-0.25	COMP04	0.652	1247.62
University of California-Los Angeles	1315	Pub	R1	CompSci	36	36.00	86	86	-0.18	COMP04	0.652	1247.62
University of Kansas, Main Campus	1948	Pub	R2	CompSci	16	16.00	65	65	-0.13	COMP04	0.652	1247.62
Kansas State University of Agriculture and App	1928	Pub	R2	CompSci	8	8.00	156	156	-0.12	COMP04	0.652	1247.62
Texas A & M University, Main Campus	10366	Pub	R1	CompSci	10	10.00	0	11	-0.09	COMP04	0.652	1247.62
University of California-Santa Cruz	1321	Pub	D1	CompSci	0	5.66	150	150	-0.08	COMP04	0.652	1247.62
University of Southern Mississippi	2441	Pub	D1	CompSci	0	8.09	14	14	0.02	COMP04	0.652	1247.62
University of Virginia, Main Campus	6968	Pub	R1	CompSci	9	9.00	188	188	0.03	COMP04	0.652	1247.62
University of Nebraska at Lincoln	2565	Pub	R2	CompSci	0	8.64	192	192	0.10	COMP04	0.652	1247.62
Northern Illinois University	1737	Pub	D1	CompSci	0	12.94	16	16	0.13	COMP04	0.652	1247.62
Washington State University	3800	Pub	R2	CompSci	12	12.00	81	81	0.14	COMP04	0.652	1247.62
Florida State University	1489	Pub	R2	CompSci	0	25.82	2,398	2,398	0.15	COMP04	0.652	1247.62
Wayne State University	2329	Pub	R2	CompSci	0	10.27	363	363	0.16	COMP04	0.652	1247.62
University of Oregon	3223	Pub	R2	CompSci	0	11.52	51	51	0.16	COMP04	0.652	1247.62
University of California-Irvine	1314	Pub	R1	CompSci	12	12.00	78	78	0.22	COMP04	0.652	1247.62
University of Texas at Arlington	3656	Pub	D2	CompSci	0	10.41	59	59	0.23	COMP04	0.652	1247.62
University of Hawaii at Manoa	1610	Pub	R1	CompSci	0	9.45	65	65	0.26	COMP04	0.652	1247.62
University of Florida	1535	Pub	R1	CompSci	0	7.52	267	267	0.26	COMP04	0.652	1247.62
University of Iowa	1892	Pub	R1	CompSci	12	12.00	620	620	0.27	COMP04	0.652	1247.62
University of South Carolina at Columbia	3448	Pub	R2	CompSci	0	26.15	0	26	0.27	COMP04	0.652	1247.62
University of Oklahoma, Norman Campus	3184	Pub	R2	CompSci	15	15.00	768	768	0.28	COMP04	0.652	1247.62
Oklahoma State University, All Campuses	3170	Pub	R2	CompSci	0	6.93	54	54	0.29	COMP04	0.652	1247.62
Florida Atlantic University	1481	Pub	D2	CompSci	0	5.08	0	5	0.32	COMP04	0.652	1247.62
Northern Arizona University	1082	Pub	D2	CompSci	0	1.86	0	2	0.32	COMP04	0.652	1247.62
University of Vermont	3696	Pub	D2	CompSci	0	5.66	0	6	0.32	COMP04	0.652	1247.62
University of Houston-University Park	3652	Pub	D1	CompSci	0	13.53	33	33	0.33	COMP04	0.652	1247.62

Table 5-A.12: Segmentation Array: Computer Science

School	FICE	IOC	Carnegie Class	Academic Discipline	Faculty	Faculty (adjusted)	R&D Expenditures	R&D Exp (adjusted)	Factor Score	Segment	Segment RU Fraction	Segment Faculty
Western Michigan University	2330	Pub	D1	CompSci	0	10.04	0	10	0.36	COMP04	0.652	1247.62
University of Rhode Island	3414	Pub	R2	CompSci	0	7.52	0	8	0.38	COMP04	0.652	1247.62
Temple University	3371	Pub	R2	CompSci	0	17.02	0	17	0.38	COMP04	0.652	1247.62
Mississippi State University	2423	Pub	R2	CompSci	0	10.64	0	11	0.39	COMP04	0.652	1247.62
University of Georgia	1598	Pub	R1	CompSci	0	7.06	772	772	0.39	COMP04	0.652	1247.62
Arizona State University	1081	Pub	R2	CompSci	0	31.02	0	31	0.40	COMP04	0.652	1247.62
SUNY at Binghamton	2836	Pub	D1	CompSci	0	14.74	136	136	0.40	COMP04	0.652	1247.62
SUNY at Albany	2835	Pub	R2	CompSci	0	8.78	55	55	0.40	COMP04	0.652	1247.62
Cleveland State University	3032	Pub	D2	CompSci	0	13.14	62	62	0.41	COMP04	0.652	1247.62
Southern Illinois University-Carbondale	1758	Pub	R2	CompSci	0	11.09	0	11	0.42	COMP04	0.652	1247.62
Colorado State University	1350	Pub	R1	CompSci	0	17.71	269	269	0.42	COMP04	0.652	1247.62
University of California-San Diego	1317	Pub	R1	CompSci	9	9.00	316	316	0.43	COMP04	0.652	1247.62
University of Tennessee at Knoxville	3530	Pub	R1	CompSci	0	25.72	0	26	0.43	COMP04	0.652	1247.62
Old Dominion University	3728	Pub	D2	CompSci	0	6.37	69	69	0.43	COMP04	0.652	1247.62
North Carolina State University at Raleigh	2972	Pub	R1	CompSci	0	17.46	265	265	0.44	COMP04	0.652	1247.62
Ball State University	1786	Pub	D1	CompSci	0	4.98	0	5	0.44	COMP04	0.652	1247.62
University of Maine at Orono	2053	Pub	D2	CompSci	0	1.40	82	82	0.45	COMP04	0.652	1247.62
Bowling Green State University, All Campuses	3018	Pub	D1	CompSci	0	18.52	4	4	0.45	COMP04	0.652	1247.62
Miami University, All Campuses	7104	Pub	D1	CompSci	0	11.97	0	12	0.46	COMP04	0.652	1247.62
University of California-Berkeley	1312	Pub	R1	CompSci	30	30.00	50	50	0.47	COMP04	0.652	1247.62
University of Alabama at Birmingham	1052	Pub	D2	CompSci	0	6.11	1	1	0.47	COMP04	0.652	1247.62
North Dakota State University, All Campuses	9265	Pub	D2	CompSci	0	12.79	0	13	0.48	COMP04	0.652	1247.62
University of New Mexico, All Campuses	10313	Pub	R1	CompSci	0	18.88	7	7	0.50	COMP04	0.652	1247.62
New Mexico State University, All Campuses	2657	Pub	R1	CompSci	0	23.53	155	155	0.50	COMP04	0.652	1247.62
Oregon State University	3210	Pub	R1	CompSci	0	19.35	219	219	0.50	COMP04	0.652	1247.62
Kent State University, All Campuses	3051	Pub	D1	CompSci	0	4.32	0	4	0.50	COMP04	0.652	1247.62
Middle Tennesse State University	3510	Pub	D2	CompSci	0	3.51	0	4	0.51	COMP04	0.652	1247.62
Georgia State University	1574	Pub	D1	CompSci	0	19.13	3	3	0.51	COMP04	0.652	1247.62
University of Kentucky, Main Campus	1989	Pub	R1	CompSci	0	22.55	3	3	0.53	COMP04	0.652	1247.62
University of Missouri, Columbia	2516	Pub	R1	CompSci	0	5.79	0	6	0.53	COMP04	0.652	1247.62
University of Arkansas, Main Campus	1108	Pub	D1	CompSci	0	9.16	0	9	0.57	COMP04	0.652	1247.62
University of South Dakota	3474	Pub	D2	CompSci	0	2.71	0	3	0.57	COMP04	0.652	1247.62
University of New Hampshire, Main Campus	2589	Pub	D2	CompSci	0	16.47	0	16	0.57	COMP04	0.652	1247.62
University of Texas at Dallas	9741	Pub	D2	CompSci	0	10.74	332	332	0.59	COMP04	0.652	1247.62
Virginia Commonwealth University	3735	Pub	R2	CompSci	0	7.74	0	8	0.61	COMP04	0.652	1247.62
University of North Dakota, All Campuses	3005	Pub	D2	CompSci	0	13.93	0	14	0.62	COMP04	0.652	1247.62
Ohio University, All Campuses	3100	Pub	D1	CompSci	0	7.52	0	8	0.62	COMP04	0.652	1247.62
University of Alabama	1051	Pub	D1	CompSci	0	14.38	0	14	0.63	COMP04	0.652	1247.62
University of New Orleans	2,015	Pub	D2	CompSci	0	6.31	417	417	0.63	COMP04	0.652	1247.62
Tennessee Technological University	3523	Pub	D2	CompSci	0	4.26	26	26	0.64	COMP04	0.652	1247.62
University of Wyoming	3932	Pub	R2	CompSci	0	18.83	0	19	0.65	COMP04	0.652	1247.62
University of Montana	2536	Pub	D1	CompSci	0	4.26	6	6	0.65	COMP04	0.652	1247.62
Illinois State University	1692	Pub	D2	CompSci	0	16.10	0	16	0.66	COMP04	0.652	1247.62
College of William and Mary	3705	Pub	D1	CompSci	0	9.67	9	9	0.66	COMP04	0.652	1247.62

Table 5-A.12: Segmentation Array: Computer Science

School	FICE	TOC	Carnegie Class	Academic Discipline	Faculty	Faculty (adjusted)	R&D Expenditures	R&D Exp (adjusted)	Factor Score	Segment	Segment RU Fraction	Segment Faculty
University of California-Santa Barbara	1320	Pub	R2	CompSci	8	8.00	310	310	0.66	COMP04	0.652	1247.62
Montana State University	2532	Pub	D2	CompSci	0	6.31	0	6	0.66	COMP04	0.652	1247.62
Utah State University	3677	Pub	R2	CompSci	0	12.35	44	44	0.67	COMP04	0.652	1247.62
University of Toledo	3131	Pub	D1	CompSci	0	9.16	0	9	0.67	COMP04	0.652	1247.62
University of South Florida	1537	Pub	D1	CompSci	0	6.31	0	6	0.68	COMP04	0.652	1247.62
University of Mississippi, Main Campus	2440	Pub	D1	CompSci	0	12.38	0	12	0.68	COMP04	0.652	1247.62
University of Idaho	1626	Pub	D2	CompSci	0	10.64	3	3	0.69	COMP04	0.652	1247.62
Portland State University	3216	Pub	D2	CompSci	0	2.71	0	3	0.70	COMP04	0.652	1247.62
University of Louisville	1999	Pub	D1	CompSci	0	17.11	0	17	0.70	COMP04	0.652	1247.62
Auburn University, Main Campus	1009	Pub	R2	CompSci	0	14.75	0	15	0.70	COMP04	0.652	1247.62
Clemson University	3425	Pub	D1	CompSci	0	15.03	0	15	0.70	COMP04	0.652	1247.62
Indiana State University, Terre Haute	9563	Pub	D2	CompSci	0	8.64	0	9	0.73	COMP04	0.652	1247.62
Texas Woman's University	3646	Pub	D1	CompSci	0	4.11	155	155	0.76	COMP04	0.652	1247.62
SUNY College of Environmental Science and F	2851	Pub	D2	CompSci	0	4.98	0	5	0.76	COMP04	0.652	1247.62
Colorado School of Mines	1348	Pub	D2	CompSci	0	3.51	0	4	0.77	COMP04	0.652	1247.62
Memphis State University	3509	Pub	D1	CompSci	0	2.71	0	3	0.77	COMP04	0.652	1247.62
University of Maryland Baltimore County	2105	Pub	D2	CompSci	0	1.86	0	2	0.78	COMP04	0.652	1247.62
University of Missouri, Kansas City	2518	Pub	D2	CompSci	0	1.86	0	2	0.78	COMP04	0.652	1247.62
University of Nevada-Reno	2568	Pub	D2	CompSci	0	1.86	0	2	0.78	COMP04	0.652	1247.62
University of Northern Colorado	1349	Pub	D1	CompSci	0	0.96	0	1	0.78	COMP04	0.652	1247.62
Idaho State University	1620	Pub	D2	CompSci	0	0.00	0 •		•	COMP04	0.652	1247.62
Louisiana State University and Agric & Mech Co	2010	Pub	R1	CompSci	0	0.00	0 •		•	COMP04	0.652	1247.62
Louisiana Tech University	2008	Pub	D2	CompSci	0	0.00	0 •		•	COMP04	0.652	1247.62
Texas Tech University	3644	Pub	D1	CompSci	0	0.00	0 •		•	COMP04	0.652	1247.62
University of Akron, All Campuses	3123	Pub	D1	CompSci	0	0.00	9	9	•	COMP04	0.652	1247.62
University of California-Davis	1313	Pub	R1	CompSci	0	0.00	0	•	•	COMP04	0.652	1247.62
University of California-Riverside	1316	Pub	D1	CompSci	0	0.00	0 •		•	COMP04	0.652	1247.62
University of California-San Francisco	1319	Pub	R1	CompSci	0	0.00	5	5	•	COMP04	0.652	1247.62
University of Cincinnati, All Campuses	3125	Pub	R1	CompSci	0	0.00	0 •		•	COMP04	0.652	1247.62
University of Missouri, Saint Louis	2519	Pub	D2	CompSci	0	0.00	0 •		•	COMP04	0.652	1247.62
University of North Carolina at Greensboro	2976	Pub	D2	CompSci	0	0.00	24	24	•	COMP04	0.652	1247.62
University of Wisconsin-Milwaukee	3996	Pub	D1	CompSci	0	0.00	0 •		•	COMP04	0.652	1247.62
West Virginia University	3827	Pub	R2	CompSci	0	0.00	42	42	•	COMP04	0.652	1247.62